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HALBERT P. GILLETTE, President and Editor
R. W. HUME, Vice-President
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Cleveland Office, 1211 Swetland Bldg.: E. C. Kelly, Manager
New York Office, 415 Lexington Avenue: ERWIN T. EYLER, Eastern Manager

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Predicting Backward

The word predict usually implies a future date, as to the occurrance of an event, such as an eclipse; but there is a form of prediction that relates to past events. For example, William Smith, that English surveyor who became "the father of geology" as a result of study of the rock strata at a coal mine, told the mine owner that if he would sink a shaft at a certain point to a certain depth he would strike the coal bed that had been displaced by a fault. He made a prediction of a future event, namely the finding of the lost coal bed, but it related to a geological event that had occurred ages before when the strata had cracked and had slid past one another. So the only futurity involved in his prediction related to the acts of men and not to the acts of nature. The natural event was ages old. The artificial event was yet to occur. When it did occur (by the sinking of the shaft) Smith was found to be right. His geological theory was confirmed.

A little thought shows that it is just as difficult to predict backward in the way used by geologists, as forward in the way used by astronomers. In both cases theory guides the actions of the predictor, and only correct theory guides him aright. The great job, then, is to devise correct theories by which to solve the mysteries of nature.

Fortunately nearly all scientific theories can be used to predict backward as well as forward. It is exceedinly important to appreciate this fact, for it furnishes a means by which to test any theory. For example, it is my theory that wage levels in each country vary directly with the per capita money in circulation in that country and with its velocity of circulation, or as the product of those two factors. If I had to wait until future changes in wage level had occured, in order to test the theory, I might not live long enough to satisfy myself that the theory is correct. But since per capita money statistics are available for each year for nearly 90 years, and since other statistics enable me to calculate velocity of circulation for nearly 60 years, I can test the theory closely for 60 years and roughly for 90 years back. Such a check shows the theory to be substantially in accord with the facts as to past wage levels, and thus I am justified in using the theory in forecasting probable future wage levels.

Simple as such a process of testing theories is, surprisingly few economic theories have been subjected to the test. Take, for instance, any theory that is commonly used by speculators in the stock market and you will look in vain for a careful test of it by the method of predicting backward. Is it A's theory that "tips" given by B are usually correct as to stock market movements, because of broker B's superior knowledge? A ready means is usually available for testing B's knowledge, by comparing all his past predictions with the subsequent events over a considerable number of years. Yet how many speculators ever use such a test? If many did, the game of fleecing the lambs would have long ceased to be profitable, for most of the lambs are either tip operators or believers in hunches.

In the field of science there is a vast mass of quantitative facts that remain to be explained and correlated. Theories, suggested by analogies between partly known classes of facts and well known classes of facts, can be readily devised by any engineer possessed of but slight originality. Then each theory can be put to the test by drawing conclusions from it and looking to see whether published facts agree with the conclusions. Where the facts are numerical, and where the theory is quantitative, a close agreement between fact and theory indicates probable correctness of the theory. And when the numerical facts cover a wide range of conditions, yet are in accord with the theory, the probability of the truth of the theories increases, finally reaching what amounts to certainty when the theory agrees quantitatively with a wide range of facts of a class that the theory was not originally designed to explain.

As an example of predicting backward, the writer published an article in the August issue of Engineering and Contracting entitled "The Inertial Theory of Motion and Gravitation," in which a theory of self-propulsion of moving bodies was used to deduce the Einstein formulas of relativity. The theory enabled the writer to deduce the three basic relativity formulas, and since precise predictions based on those formulas have been precisely verified, it follows that the writer's self-propulsive theory is probably correct.

Deductions of other established formulas from the self-propulsive theory will appear from time to time in future issues of Engineering and Contracting. Engineers who are interested in the derivation and testing of scientific theories should find such articles of value.

H. P. Gillette

More Evidence that All Moving Bodies Are Self-Propelling

By HALBERT P. GILLETTE, Editor

The Ancient Greek philosophers believed that stars are self-propelling. Des Cartes, the great French mathematician and inventor of analytical geometry, devised a vortex theory to explain the motion of the planets around the sun. He thought that planets are swept along by currents of ether. But Newton came along shortly afterward and announced his first law of motion, in which rest and motion were assumed to be equally "natural," neither of them requiring a cause for existence. Just as the absence of motion seemed to call for no explanatory cause, so the presence of motion, according to Newton, called for no explanatory cause. Everybody at rest tends to remain at rest, and everybody in motion tends to remain in motion in the same direction and with unchanged velocity, he tells us. And having accepted this dictum, the scientific world has, ever since, made no attempt to explain the motion of the celestial spheres, further than as they are affected by gravitation.

But Einstein gave this complacent scientific world a terrific shock when he proved that the old conception of energy was not exactly correct. Even Newton's mechanical axioms may be questioned since Einstein's predictions have been verified.

In the August 1927, issue of Engineering and Contracting, I deduced the three Einstein relativity formulas by the aid of a new theory, which should alone suffice to prove the truth of the theory. But further proof is always desirable where a new theory is involved. Fortunately it is the outstanding characteristic of a true theory that it leads to discovery of new facts and to explanation of old phenomena that before were enigmas.

This theory, which I called the inertial radiation theory of motion and gravitation (Engineering and Contracting, Aug. 1927) explains the motion of stellar bodies as being due to the emission of a greater number of etherites from the rear than from the front face of each of the component units (i. e. the electrons) of matter. And it explains gravitation as being caused by the pressure of etherites mutually radiated from any two bodies, which pressure on the near faces results in the liberation of more etherites from the far faces than from the near faces of the two bodies, much as evaporation of a liquid is greater from those parts of its surface where pressure upon it is less.

Taking this etherite escape theory, let us apply it to a planet and assume that a long enough time has elapsed to make its effect manifest. Obviously the loss of etherites means the loss of energy, and, just as a skyrocket tends to lose velocity, so a self-propelled planet tends to lose velocity. But this means that its centrifugal force decreases, and that consequently it falls toward the sun. The act of falling toward the sun increases its velocity. Hence the period of revolution of a planet should decrease. Is there any evidence that this occurs? It has long been known that the eclipses of the moon occur about 2.4 seconds earlier each century than the Newtonian theory would explain; and Prof. Newcomb (see Encyclopedia Brittanica under moon) has called this "the most perplexing enigma in astronomy" and one that "still defies solution." We now see that this gain in the moon's orbital velocity is explained by the theory of self-propulsion.

I have recently come upon several other evidences of accelerated velocity of planets. I refer to the fact that the sun-spot periods occur at less intervals than the periods of the planets that undoubtedly cause them. In an article on the cause and effect of sun-spots, in "Water Works" for August, 1927, I showed why the 11.15-year sun-spot period is less by about 6 per cent than the 11.86-year period of revolution of Jupiter. In a forthcoming article in Engineering and Contracting, the reason for this difference will be explained at greater length, and it will be shown that each of the eight planets causes a sun-spot period that is less than the period of revolution of the planet. And, what is of great importance, it will be shown that a general law exists by which the gain in velocity of each planet is calculable, and that the gains thus calculated correspond almost exactly for each planet with the difference between its period of revolution and the sun-spot period attributable to it. Mercury, for example, revolves in 88 days, and causes a sun-spot period of 68.5 days. The gain in velocity since Mercury was ejected from the sun is thus seen to be 19.5 days or slightly more than 22 per cent; whereas Jupiter's gain during the same period is slightly less than 6 per cent; and these percentage gains are proportional to their orbital velocities, which is precisely what should be the case if their moments of momentum remain constant.

Knowing this, it is feasible to calculate the age of the planets, if the moon gains 2.4 seconds per century, and the calculation shows the age of the planets to be a little less than 1,000 million years. Incidently it may be remarked that Russell has estimated the age of the earth's crust at 8,000 million years, using the uranium-lead ratio method; but as Brooks pertinently remarks, "This may be too high, as some lead may have been present when the earth's crust was formed." Recently de Geer has proved that the most careful previous estimate of the age of the Niagara Falls gorge is four times its true age; and there are other reasons for believing that geological estimates of the age of the earth and its rocks are similarily in error. The uranium-lead ratio method is perhaps the most reliable method hitherto available for estimating the age of the earth's crust, but it assumes that all the lead has evolved from the uranium after the rocks were formed, which is obviously a very questionable assumption. This uranium-lead method should give an estimated age in excess of the true age, because it seems probable that some lead existed in the materials that were ejected from the sun to form the earth.

The theory that stellar bodies ejected parts of themselves to form other stellar bodies (see Engineering and Contracting, July, 1926) leads to the conclusion that the parent star and its planet revolve around their common center of mass. This is known to be the case with our earth and its moon. If then we assume it to be the case with the sun and each of its planetary bodies, we finally conclude that all the bodies in the solar system are revolving about the center of mass of the solar system. This center of mass is probably quite close to the center of the sun, for the mass of the largest known planet, Jupiter, is only one-thousandth that of the sun. If then Jupiter and the sun are revolving about their center of mass, and if that center of mass is revolving about the center of mass of the solar system, we can easily explain why the sun-spot period caused by Jupiter is less than Jupiter's period of revolution provided we assume that Jupiter has gained greater orbital velocity than the sun has gained about the same center since Jupiter was formed. But this is exactly what must have occured according to our self-propulsion theory, for Jupiter would have vastly greater orbital velocity than the sun about their common center, and would consequently lose energy at a vastly greater rate, and gain orbital velocity accordingly. Then with the sun and Jupiter revolving about a common center, which in turn is revolving about a relatively fixed center (that of the solar universe), the maximum tide on the sun would occur

when the sun, Jupiter and the center of the solar system are on the same straight line. This can be easily proved, and it then follows that the solar tide (due to combined gravitation and centrifugal force) must occur at less intervals than the period of revolution of Jupiter about the sun, which is the case.

Prof. Schuster and many other investigators have concluded that the difference of 6 per cent between Jupiter's period and the main sun-spot period made it unlikely that the great sun-spot period is attributable to Jupiter. Nevertheless, much other evidence (see Earth and Sun by Huntington) has pointed toward a planetary cause of sun-spots. Not aware of the orbital acceleration of the planets, Newcomb, Schuster and others could not reconcile the difference between planet periods of revolution and the sun-spot periods. Such a reconcilliation is possible, however, if we grant that planets are self-propulsive and are moving with increasing velocity in a spiral path toward the sun, as above outlined.

The unbalanced etherite-escape theory of motion leads to the conclusion that every planetary group tends to become more dense with the lapse of time, finally resulting in collisions of the units. This would generate heat. A rotating fluid mass like the sun would thus generate heat. It has been estimated that the sun would have soon become as cold as the earth now is had there not been some means of producing more heat. Shrinkage of the sun's mass would produce heat, but what would cause shrinkage? The early theorists attributed shrinkage to cooling. But that being evidently inconsistent with the present high temperature, sun shrinkage from cooling has been abandoned as a reason for the sun's maintenance of a high temperature. Shrinkage from gravitation was next assigned as a cause, but no reason was given for such shrinkage; because if the sun consisted of planetary units the Newtonian first law of motion stood in the way of their decreasing their orbits; and if the sun consisted of a fluid mass whose particles pressed upon one another, gravitation could not explain shrinkage without loss of temperature as a contributing cause. All these difficulties vanish, however, if we assume that the rotating parts of the sun are losing energy, and are consequently gravitating more closely toward its center. Then since in a rotating fluid mass the outer layers have the greater velocity, they must lose energy fastest and thus eventually impinge upon the layers beneath, causing heat. Hence the self-propulsive theory explains an enigma and is in accord with the fact of the high temperature of the sun.

The self-propulsive theory is in accord with and explains the long known and puzzling gain in the moon's velocity. It explains the maintenance of high temperature on the sun. It is in accord with the difference between the sun-spot periods and the periods of revolution of each of the 8 planets (as will be fully shown in a later article in Engineering and Contracting). It is a corollary of the theory used in deducing the relativity formulas of Einstein by the method applied in the above mentioned article in Engineering and Contracting. It seems, therefore, to rest upon evidence that is conclusive as to its truth.

If orbital motion is self-produced, it is but a step to the inference that all motion is of the same character. And it is but another step to the conclusion that the absence of relative motion between two bodies that press upon one another is due to an escape of equal numbers of etherites from their free faces in opposite directions, causing an equilibrium. If so, statics is only camouflaged kinetics, and all pressure is evidence of the reactive push of etherites escaping in opposite directions. Using this theory it becomes possible to visualize all the fundamental principles and laws of physics.

Mechanical Spreading of Asphaltic Concrete

A concrete road finisher was used by the Griffith Paving Co., Los Angeles, Cal., on an asphaltic concrete paving job at Placentia, Orange County, California.

The work consisted of 16 miles of 18 ft. 2-course asphaltic concrete, 2½ in. and 3½ in. base course, 1½ in. top course, with a seal coat covered with chips. A 6 in. decomposed granite sub-base was first laid, using 3 in. wood forms. The height of the forms above sub-base equalled the thickness of the asphalt base course.

Before starting the work it was first necessary to determine the amount of compression under rolling. This, on a 3½ in. base, was ⅝ in., and to allow this extra thickness a ⅝ in. x 3 in. strip of wood was tacked to the top of the rail.

When laying the top course three strips 1½ in. x 3 in. x 20 ft. were tacked to the form on each side, with sections of ⅜ in. x 3 in. flat iron laid on top to allow for compression on top course. These iron strips had ears or legs, welded on each side to prevent them from being forced off by the screeds. As fast as asphalt was spread and screed by the finishing machine these strips were removed and laid ahead.

Nat Neff, county highway engineer, in cooperation with A. P. Kendig of the Raymond G. Osborne Laboratories and Engineer S. B. McCulloch, had charge of field work.

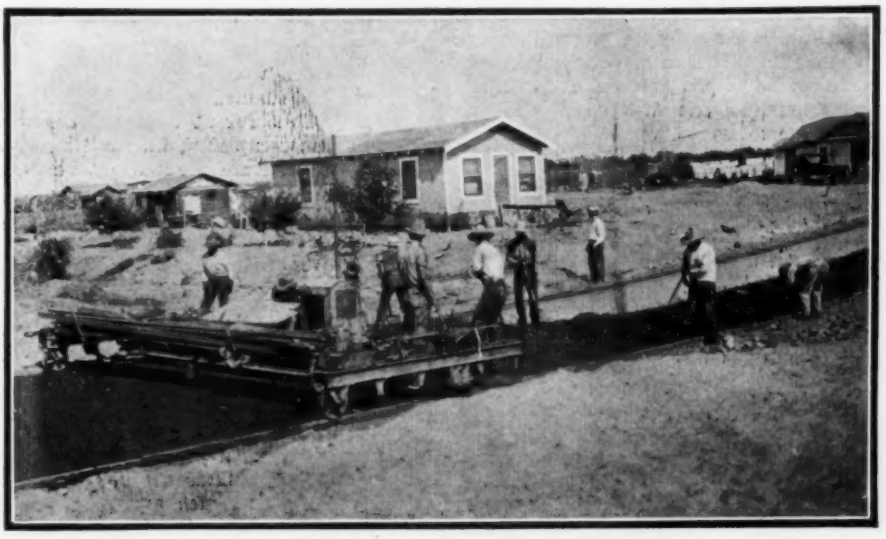
Southwest Road Show and School Expanding

Fourteen or more states instead of nine will be covered by the Third Southwest Road Show and School, which will be held in Wichita, Kan., Feb. 21-24, 1928. This expansion is made necessary by the large number of inquiries and large interested attendance at previous shows, from the central and western states, which was not anticipated at the time this road show and school was first started.

Indications at this time are that the show itself, and the number of applications for space received will be more than double that of any previous show. Arrangements have been made for additional floor space adjoining the Coliseum to take care of the overflow.

The Good Road School is receiving unusual support at this early date, and an exceptionally interesting and educational four days' program will be put on.

The show will be held under the auspices of the Wichita Thresher & Tractor Club of which F. G. Wieland, Water and Williams Sts., Wichita, is secretary, treasurer and general manager.



Concrete Finishing Machine in Use on Asphaltic Concrete Job

Arbitration for State Highway Contracts

North Dakota Provides for Compulsory Arbitration of Controversies

The legislature of North Dakota has inacted a law making legal provisions for the compulsory arbitration of controversies arising from contracts with the state highway commission. The law is now in force. It's text is as follows:

Section 1.—All controversies arising out of any contract for the construction or repair of highways entered into by the state highway commission of the state of North Dakota shall be submitted to arbitration as hereinafter provided, if the parties cannot otherwise agree. Three persons shall compose the arbitration board, one of whom shall be appointed by each of the parties and the two thus appointed shall name a third.

Section 2.—The party desiring arbitration shall make a written demand therefor and shall in such demand name the arbitrator by him selected. He shall also in such demand set forth all the controversies and claims which he desires to submit to arbitration and a concise statement of his claim with reference to such controversies. Such demand shall be served upon the opposite party, who shall, within 10 days, name in writing the arbitrator on his part, and in connection therewith shall set forth in writing his contentions with reference to the claims set forth in the demand served upon him and any additional claims or controversies which he desires to submit to arbitration on his part, with a concise statement of his claims in connection therewith. Provided, however, if the party proceeded against shall fail or refuse to name an arbitrator the moving party may apply ex parte to the judge of the district court of the county in which the improvement in the contract in question, or any part thereof, may be located for the appointment of two additional arbitrators, and if upon the appointment of an arbitrator by each of the parties, the two so appointed have been unable to agree upon a third arbitrator within five days, then either party to the controversy may, upon five days' notice, apply to such district court for the appointment of such third arbitrator.

Section 3.—When such board of arbitration shall have been appointed a submission in writing shall be executed as provided by Section 8328 compiled laws of 1913, except that such submission must provide for the entry of judgment upon the award by the district court of the county within which the improvement, or some part thereof, involved in the contract is located, which county must be specified in such submission, and which submission must be executed on the part of the state highway commission by some member thereof to be selected by such commission. Thereupon the arbitration shall proceed in accordance with the provision of Chapter 40 of the code of civil procedure of the compiled laws of 1913.

Section 4.—If either party refuses to submit to arbitration as hereinbefore provided he shall be deemed to have waived all claims and demands, and the arbitrators shall proceed to determine the controversies set forth by the moving party according to the justice of the case, and judgment shall be entered upon the award of such arbitrators in all things the same as though the submission to arbitration had been signed by both parties.

Section 5.—No right shall exist to demand arbitration against the state highway commission until the following conditions shall have been complied with; that is, the contractor must give the commission notice in writing that he claims the contract has been or will be fully performed on a day stated, which shall not be less than 10 days after the giving of such notice. At the time stated in the notice the commission shall cause the work to be inspected, and if it claims the work has not been completed it shall with all reasonable dispatch, having regard to the early completion of the work, specify the particulars in which it is incomplete and direct that it be completed accordingly, or if it considers further work necessary to bring the project up to the desired standard for acceptance either by it or the United States Bureau of Public Roads, even though it considers such contract complete, it may likewise specify any such additional work, and the contractor must proceed with all reasonable dispatch, having due regard to weather conditions, with the performance of all such additional work with a view to a speedy completion of the project. When the contractor claims in good faith, supported by the affidavit furnished to the commission, that he has completed such additional work according to the specifications furnished him and the commission fails for 10 days to accept such work as completed, he shall have the right to institute proceedings hereunder. The arbitrators shall then determine all controversies between the parties growing out of the contract, including the question whether it had been performed at the time claimed by the contractor and whether the additional work required by the commission as specified has been done, and if not it shall specify the particulars in which it has not been done and give appropriate directions with reference thereto, and shall make a proper award for any extra work it finds the contractor entitled to, making such award so far as is practicable upon the basis of the contract price, having due regard to what is just and equitable between the parties under the facts and circumstances of the case. Provided, however, in any case where controversy already exists at the time of this act taking effect and it is claimed by the contractor that the contract has been performed and he has removed his equipment from the job, arbitration may be had and all controversy settled without obligation on his part to do extra work as aforesaid.

If after the making of an award which requires the contractor to do further work, any controversies arise between the parties as to the doing of such work, such controversies may be submitted to the same arbitrators on five days' notice for further determination.

Section 6.—No arbitration shall be had hereunder unless commenced within six months after the right thereto has arisen, except in the case of controversies already existing in which case it may be commenced at any time within six months after the taking effect hereof.

Section 7.—When judgment shall have been entered against the highway commission the same shall not be collectable or enforceable by execution, but if the same provides for the payment of money by the highway commission it shall be paid in the same manner, to the same extent and out of the same funds as though the claims thus established had been recognized and allowed without arbitration, and the performance of the duty of the highway commission with reference to payment or other compliance with such judgment may be enforced by mandamus proceedings in the district courts of the states.

Section 8.—Inasmuch as there is doubt and difference of opinion as to whether the state highway commission may sue or be sued in the courts of the state, and as to whether compulsory arbitration may be resorted to for or against it, and there are substantial and important disputes pending between such commission and persons who have contracted with it, this act is declared to be an emergency measure and shall be in full force and effect immediately upon its passage and approval.

Concrete Cradles for Pipe Conduits.—A 44-page illustrated bulletin, No. 80, dealing with concrete cradles for large pipe conduits has been published by the Iowa Engineering Experiment Station, Ames, Iowa. The research investigation was conducted at Ames in cooperation with the United States Bureau of Public Roads. This bulletin deals with the action and effectiveness of cradled concrete pipe from 24 in. to 80 in. in diameter.

Bituminous Treatment of Gravel and Crushed Stone Roads

Experiences in California and Other Far Western States Given in Paper Presented Oct. 4, at 13th Annual Meeting of the American Association of State Highway Officials

By T. E. STANTON

Assistant State Highway Engineer of California, Sacramento, Calif.

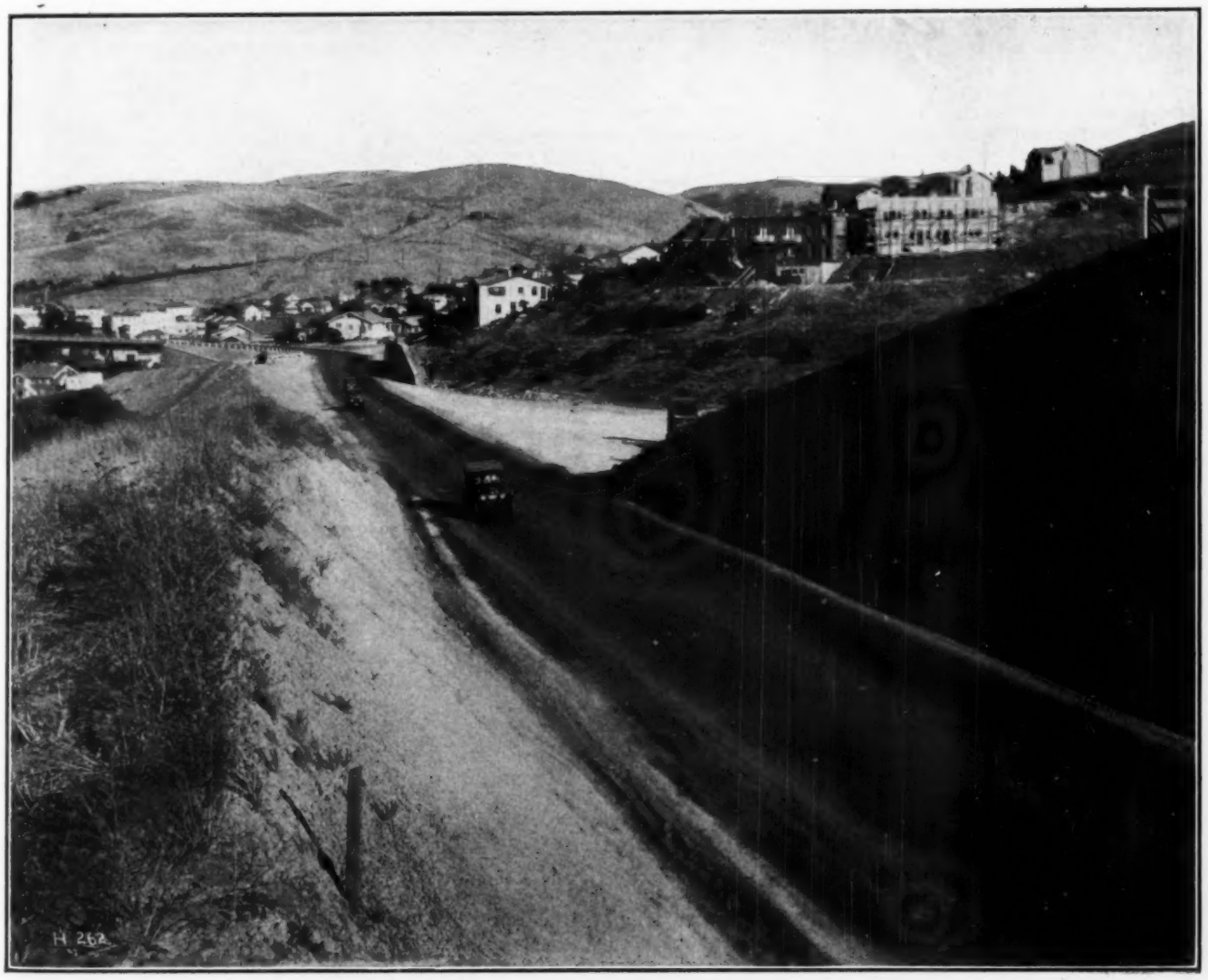
Treating roads with asphaltic oil is not a development of recent years. In California, where an abundance of asphaltic oil is available locally at a low cost, we have been oiling our roads with more or less success for over 30 years. Many states can undoubtedly produce evidence of similar practice.

Most of the early work of this nature, however, was allowed to deteriorate through lack of proper and intelligent maintenance, with the result that oil surfacing of natural soil or gravel roads came to be looked upon by the general public as more or less of a failure and the tendency has been to replace these oil roads with expensive hard surfaced pavements as rapidly as traffic requires and funds are available.

As motor traffic has increased however and highway engineers have come to realize the great economic waste involved in permitting waterbound gravel and crushed rock roads to be loosened and blown away through the joint action of vehicle and winds, a strong movement has set in all over the country towards sealing the surface so as to make it impervious to such destructive agencies.

Instead, however, of using the haphazard methods of the past the engineer has come to the conclusion that the problem is deserving of as much scientific and intelligent study as had been applied to the more expensive types of hard surfaced pavements, and as a natural corollary we have the rapid strides towards a full understanding of the problem which have been made in recent years.

To Oregon must go the credit in the west of being the first State to go extensively into the use of an asphaltic oil, relatively low in asphalt content (60 per cent to 70 per cent), locally known as "fuel oil," in surfacing the



Finished Roadway, Oil Mix Process, for Approach to Carquinez Straits Bridge

Five Foot Double Disc Harrow and Spike Tooth Harrow, Used in Mixing Oil into Gravel Road After Each ½ Gal. Application

gravel and crushed rock roads of the State by what is known as the surface treatment or penetration method; and to California the credit for most of the progress which has been made to date in the so-called "oil mix" method.

The present extensive use of fuel oil on the Pacific Coast is the direct outcome of experimental work conducted in 1923 by the Oregon State Highway Commission followed in 1924, 1925 and 1926 by several hundred miles of bituminous treatment. Success in the Oregon experiments in 1923 and of later work was due in a large measure to the prior development of an efficient maintenance organization.

The favorable results in Oregon in the preservation of modern crushed rock and gravel surfaces by the use of fuel oil led to similar experimental work in California in 1925, followed by the construction of 245 miles of oiled State highway in 1926 and over 600 miles in 1927.

The Washington and Idaho State Highway Department also constructed experimental oil treated sections in 1927, using methods adopted from Oregon practice.

So important does the Bureau of Public Roads consider this matter that it last year, in cooperation with the California State Division of Highways, initiated a special investigation of the subject, through the Regional Office, San Francisco, in charge of Dr. L. I. Hewes, Deputy Chief Engineer.

As a result of this investigation, a complete and valuable report has been drawn up by Mr. C. L. McKesson, Materials and Research Engineer of the California Division of Highways and Mr. W. N. Frickstad, Highway Engineer of the Bureau of Public Roads.

Much of the data on which this article is based was obtained as a result of the above investigation and will be found set forth in detail in the report of the engineers.

Surface Treatment. — Oregon uses the "Surface Treatment" method almost exclusively. In California probably 75 per cent of the roads oiled to date received the surface treatment and on the balance of the oil mix method was used. There is no doubt, however, but that the oil mix method will be used to a greater extent in future work.

Surface treatment with light oil as conducted in California contemplates impregnation of the surface crust of a compacted road with asphaltic oil.

The type of rock surface which lends itself most readily to a good job of this type is the fine crushed rock surface, using rock of maximum (1) in. size, which can be thoroughly bladed and worked to secure a perfectly smooth surface of uniform texture prior to oiling.

To secure a good job by the penetration method it is essential that the surface be thoroughly sound and well compacted before oiling.

The first step therefore, is the preparation of the base. If it has become rough and pitted under traffic, it is lightly scarified and trued up with a road grader, then sprinkled, dragged, and sometimes rolled if there is too much loose material on the road.

When firm and smooth, the surface is thoroughly swept with a power broom supplemented by a hand broom if necessary. All loose material and fines are removed and the rock in the surface is exposed.

The oil is then applied under pressure at the rate of ¼ to ¾ gal. per square yard and, when traffic can be detoured, allowed to penetrate without covering, the time required for penetration depending upon the texture of

First Trip with the Grader Throwing the Material from the Edge in a Windrow Toward the Center of the Road

the surface and viscosity of the oil. Two or three days are usually sufficient.

It is usually necessary however, to carry traffic through the work. In such cases the usual procedure is to oil one-half of the roadway at a time, handling traffic under control. Immediately after oiling one side, the oil is covered lightly with clean dustless screenings applied at a rate of from 50 to 150 cu. yd. per mile of full width roadway, the amount depending on the width, nature of material, traffic, etc.

As soon as the road is screened, traffic is diverted to the side just oiled and the opposite side then oiled and screened.

Following the first application of oil, the surface of the roadway is bladed and the oil coated screenings are dragged into depressions in the road surface, in order that minor inequalities in the surface may be smoothed out. The oil collects in the minor depressions and furnishes sufficient cementing material to take up the screenings. Where large amounts of screenings are used and the traffic is carried through the oiling, the blade should be operated continuously until the oil has dried up or has been absorbed by the cover material. If necessary, imperfections in the surface are repaired with premixed oil and mineral aggregate.

The second application of 2/10 to ¼ gal. of oil per square yard is spread as before and, if possible, traffic kept off so as to allow for absorption. The road is then screened again before throwing open to traffic. High viscosity oils require more screenings than the thinner oils. Clean screenings only should be used as fine material including dust absorbs the oil before it can penetrate the base, with the resulting formation of a thin oil mat on the surface which lacks adhesion to the base and will not stand up under traffic.

On the Fifth Trip with the Grader, the Windrow Is Split and Flattened Out Toward Each Edge of the Road

When traffic can be detoured entirely off the work, the screenings are not applied until after the second application of oil as we have found by experience that the same results as regards smoothing up, correcting defects, etc., are secured by covering and dragging after the second application of oil as are secured by covering and dragging after each application and it is usually found possible to get by with materially less screenings when made in one application than in two with the resultant lower cost.

The Fourth Trip Places All the Material in One Large Windrow in the Center of the Road

An alternate method to the use of light oil for both applications is to use light fuel oil (60% to 70%) on the first application in order to secure penetration and a heavy asphaltic road oil (90% to 95%) on the second application. This process, however, requires a special heating plant for the heavy oil. In some cases emulsified heavy oil is being used, thus making it unnecessary to install a heating plant. The emulsified liquid contains 50% of asphalt and 50% of water so that when the same amount of liquid per square yard is spread there is only one-half as much asphalt, the reduced quantity of asphalt thus at least partially offsetting the cost of emulsification. A number of miles have been oiled in California in this manner and the process is under close observation. The advantage to be gained by this process, if any, is the ability to spread light applications of heavy asphaltic oils without the use of expensive and troublesome heating equipment.

No recommendations can be formulated as yet relative to this special treatment method, though the results secured thus far have not been unsatisfactory.

Maximum penetration of the oil into the compacted road surface should be one of the principal objectives. This penetration results in a gradual transition in texture of the top one or two inches of the crust from the rather rich condition of the surface to the lean

condition found at the maximum depth of penetration without any distinct binding plane or plane of separation which is unstable under traffic.

After the surface oiling operations have been completed it is essential that thorough and incessant maintenance set in immediately. Scarred places should be thoroughly cleaned, broomed out by hand and swabbed with oil followed by a dash of screenings. Each scar no matter how small should be treated.

If it is not possible to immediately treat scarred places they will soon develop into pot holes. In such cases, a pre-mixture of oil and rock should be thoroughly tamped into the pot hole after cleaning it out thoroughly and swabbing it lightly with oil.

(Sample Card)
Please hand to Traffic Officer at Other End
One Way Traffic
Keep Off the Oil
Except When Passing Stalled Cars
FIVE MILES PER HOUR
When On the Oil
Following These Rules will Keep Oil Off Your Car
Also Expedite Our Work
THANK YOU!

(Sample Card)
ATTENTION!
THIS ROAD IS BEING OIL TREATED
PLEASE EXTEND YOUR COOPERATION
BY DRIVING SLOWLY AND COMPLYING
WITH SIGNS

Oil Mix Method.—Surface oiling is only successful where the base is firmly bound and all loose material on the surface can be eliminated by brooming.

On the Sixth Trip Throwing the Material in Windrow Toward the Edge of the Road

Handling Traffic.—On heavily traveled roads, it is generally found necessary to carry traffic through the work. This is not an unmitigated evil, however, as the traffic passing over the oiled surface, especially over the first or primary coat, reveals any weak places which can be immediately repaired.

When traffic is allowed through the work, however, the cars are liable to become spattered with oil and the irate motorist is inclined to severely criticize the Department. In order to reduce the criticism to a minimum, printed cards are handed each motorist as he approaches the work warning him that the road is being oiled and requesting that he maintain a speed through the work of not to exceed five miles per hour.

The base can be placed in a properly bound condition only when the rock from which it is made has cementing qualities of a high order or there is suitable material available which has a high binding value.

In many of the arid and desert regions of California no good cementing base rock is available, nor is there any suitable local clay or other binding material. In these sections it is impossible to secure a base sufficiently stable to enable the surface oiling method to be adopted with any success.

We were forced in such cases to either abandon the use of oil altogether or to adopt some other process than the penetration method. As a result, the oil mix method was developed. The use of this method, while particularly adapted to sections where there is no good binder available, is being extended to cover crushed rock roads in other sections of the State, where, even though good binder may be available, it is desired to immediately oil a base in such rough condition that it must be scarified several inches in depth in order to properly smooth up or where it is desired to oil a new road surface before traffic has had time to thoroughly compact the base and surface material.

Those who have become expert in this method of oiling prefer it to the oil surface method, as a smoother riding surface can usually be secured and the resultant maintenance cost under average conditions is somewhat less, owing to the fact that when the work is properly done practically no surface patching is necessary.

Where the grading of the base material shows approximately 50% fines passing a 10 mesh approximately one-half gallon of oil per square yard per inch of depth is required under the mixing method or a total of 1½ gal. for a three-inch mat, as against approximately ½ gal. total in the case of the oil penetration method. The cost of oiling is increased to this extent. On the other hand, an appreciable saving is made in the cost of screening, which is unnecessary in the oil mix method.

The mixing method produces a layer of mineral aggregate and bitumen closely akin to asphaltic concrete. The same principles of grading affect its stability. Skilled workers can produce an oiled surface which is as smooth as the surface ordinarily attained with asphaltic concrete.

Methods of Construction. — The method of construction is briefly described as follows:

If the existing road has a rough or unequal surface it is first scarified lightly and then smoothed by grading or dragging loose material into depressions.

After this preliminary smoothing, the road is scarified to a uniform depth of 2" to 3", according to the thickness of bituminous surface desired.

60% to 70% fuel oil is applied in two or three applications, each consisting of about one-half gallon per square yard.

The oil is mixed with the loose material after each application by means of a disc harrow, sometimes followed by a spring tooth harrow.

As soon as the oil distributor starts the disc-harrow pulls in behind and begins mixing, going back and forth over the section oiled until the distributor returns with another tank load of oil. This harrowing operation cannot be overdone.

The second and third oil applications are disc-harrowed in the same manner as the first application.

The material is then bladed from the side to the center of the road with a road grader, the first trip with the grader lining up the edge in a straight line and throwing the material toward the center. A second trip with the grader flattens out toward the center the ridge thrown up by the first trip. The third trip windrows toward the

center of the material flattened out by the second trip. Two adjacent windrows at the center are the result after the completion of the third trip on both sides of the road. The fourth trip with the grader lays one windrow on top of the other and the fifth trip splits this windrow in two, flattening out the material which is now on its way back to the edge of the road. The process is then repeated, usually with a ten foot grader. Sometimes the mixing is done with a Best tractor, pulling two graders with the blades set in opposite directions.

The final mixing is entrusted to an experienced man who has learned by experience the proper color which must be obtained for best results. The amount of mixing and number of trips depends somewhat on the temperature, character of material being mixed and the viscosity of the oil. The process of mixing is continued until the rock is thoroughly coated with oil and until the entire mixture has attained a uniform brown color. The material is sometimes turned over from thirty to forty times.

A properly curved mold board set at approximately 45° angle and operated at a relatively high speed is essential for proper mixing. The tractors used for mixing are usually governed to operate in second gear at a speed of four miles per hour. This speed is essential in order to obtain a rolling action thus turning the material completely over on the face of the mold board instead of a sliding or crowding action.

After the material is thoroughly mixed, it is bladed to a uniform cross section by the finish grader and maintained smooth under traffic by a light grader for several days. The last grading should shape only the top one inch.

It is essential that an experienced and expert operator be used for the finish mixing and spreading. If not handled properly, the mixed material may be spread too thin in places and unnecessarily thick in others, particularly on superelevated curves. Insufficient thickness results in early raveling of the surface which must be patched. When the surface ravels, the usual method of repair is to paint the surface of the resultant hole lightly with fuel oil and then fill the cavity with premixed ¾ in. rock and oil tamped or rolled into place.

On some of our work a 4-ton roller with blade and scarifier attachments has been used on the finishing before opening to traffic and also on the subsequent maintenance under traffic. The roller shoves the coarser rock into the surface and at the same time compacts and evens up the surfacing. Under maintenance, the roller operator proceeds over the road adding loose dry material where the surface is apparently too rich and rolling this material into the surface. When the surface has become corrugated from various causes, it is lightly scarified, additional rock added, and the surface smoothed up with the blade and rolled into place. Some of our men believe this light roller with scarifier attachment is more effective than a one man grader with scarifier.

Following is a summary of the different stages followed from beginning to end of a typical oil mix job:

1. Preliminary Scarifying
2. Balance Grading
3. Final Scarifying
4. First Application of Oil
5. Disc Harrowing
6. Second Application of Oil
7. Disc Harrowing
8. Third Application of Oil
9. Disc Harrowing
10. Preliminary or Rough Blade Mixing
11. Final or Finish Blade Mixing
12. Spreading Mix
13. Surfacing compacting and smoothing
14. Seal Coat (if needed)
15. Correction of Construction defects and maintenance.

The principles involved are similar to those governing asphaltic concrete excepting that the low viscosity asphaltic binder used in this process covers the particles with a thinner film than does the harder asphalt. Tests indicate that three-fourths as much light oil should be used as asphalt for like mixtures, though definite standards of quantity of oil have not been finally developed. Experienced operators can accurately judge requirements by appearance. A stain test modified from sheet asphalt practice promises to be useful. The amount of oil depends primarily upon the amount of sand and dust passing a ten mesh screen.

Experience has demonstrated that the amount of oil to be used should be kept at a minimum.

The percentage of oil per inch of depth in the finished surface which will give the most satisfactory results depends on the physical characteristics of the surface material to be oiled and on the grading. Porous volcanic rock may require twice as much oil as a hard rock or gravel. Extensive studies have been made, both in the laboratory and field, of the percentage of oil required for different gradings of the aggregate from a given source. The fuel oil content which will give satisfactory results is surprisingly low.

In Oregon as low as from 0.9% to 1.0% of bitumen has been found holding a road. In California, the percentage ranges from 2% to 7% with an average of 3% to 4%.

In order to secure best results, a screen analysis of the road material should be made prior to oiling.

Aggregate containing from 40% to 60% of ten mesh material usually gives more satisfactory and stable results than aggregate containing less than 40% passing a ten mesh.

Formula for Percentage of Oil.—Efforts are being made to derive a formula by which the percentage of oil required can be determined when the grading of the coarse and fine aggregate is known.

Following is a formula suggested by Mr. McKesson:

$$P=0.015A+0.03b+0.17C$$

When

P=Percent of oil required

A=Percent of Material retained on the 10 mesh

B=Percent of Material passing a 10 and retained on a 200 mesh

C=Percent of Material passing a 200 mesh.

Example

12.6%	passing a 200 mesh at 0.17 requires.....	2.14% oil
45.2%	passing a 10 mesh at 0.03 requires.....	1.35% oil
54.8%	retained on a 10 mesh at 0.015 requires.....	0.82% oil
100%		4.31% oil

The above formula is not proposed however as a standard for practice but is recommended as a simple formula to be used in preliminary determinations of the probable amount of oil required by a given aggregate.

A hard non-porous gravel will usually require less oil and a porous volcanic rock a higher percentage.

In the final analysis the amount of oil used must be governed by the appearance and the mixing is continued until the material assumes a dark brown or chestnut color.

Correction of Construction Defects and Maintenance.—Construction defects are very apt to occur, especially when the work has been performed by a crew which has not had a great deal of experience. The defects consist of spots too rich or fat or which are too lean.

The spots which are too rich in oil may corrugate or rut. These places are easily rescarified and remixed. More dry material is brought up from below and mixed in until the proper color is secured.

One motor grader with 8 ft. blade and scarifier attachment can remix from 500 to 1,000 of 20 ft. roadway per 8 hour day, depending upon the temperature, this costing from $90 to $180 per mile.

This rescarifying and remixing of a too rich road is a job calling for much experience because of the fact that considerably less than one-half inch of additional dry material is usually sufficient to reduce the mix to the proper consistency.

If too lean a mix is secured either originally or after remixing it is customary to seal the surface with a light application of oil, approximating ⅛ gal.

Relative Smoothness.—It has been found possible to secure a smoother road by the oil mix than by the surface treatment process.

The relative smoothness of our high-

ways in California is determined by means of the "Roughometer."

Approximately 273 miles of surface oiled and mixed oiled roads were recently tested for smoothness with the following results:

Relative Roughness of Oiled Roads Measured by the Roughometer

Surface Oiled					
District	II	24.99	miles	Roughness	28.6"
"	III	16.15	"	"	59.9"
"	IV	85.21	"	"	55.7"
"	X	27.21	"	"	63.9"
Total		153.56			
Average Roughness					53.2"
Oil Mix					
District	III	35.96	miles	Roughness	55.0"
"	IV	1.73	"	"	22.4"
"	VI	16.47	"	"	28.7"
"	VIII	55.88	"	"	14.1"
"	X	9.37	"	"	50.1"
Total		119.41			
Average Roughness					31.6"

It will be noted that the "oil mix" sections in Districts IV, VI and VIII show much better results than Districts III and X, the best results by far having been obtained in District VIII.

The good results obtained in District VIII can be attributed to the careful and thorough study of the mix method and the length of time the work measured has been under maintenance in addition to the fact that a smaller sized aggregate was used than on the work in Districts III and X. The oil mixed process was developed in District VIII and the results secured are a direct evidence of the skill developed in construction methods and the fact that roads constructed by this process with 1 in. down material become smoother with age if consistently maintained by blading under traffic. In addition to careful construction methods the good results secured with the "oil mix" method in Districts IV and VI can be attributed to constant maintenance under heavy traffic, especially during the period when the surface was being consolidated. The section in District IV being on the approach to the Carquinez Straights Bridge, where the traffic averaged over 4,000 vehicles per day during July and August this year, and the section in District VI being adjacent to the Yosemite National Park on the all year road into the Valley where the traffic averaged over 500 cars per day during the same months.

The relatively poor showing of the "oil mix" sections in Districts III and X can be attributed to the recent construction of the Sections which are on rather lightly traveled roads, insufficient dragging during the period of consolidation and also to the large amount of coarse aggregate in the surface. They may improve under traffic and maintenance.

The good results of the surface oiling in District II is an evidence of the great care used by the Distict Engineer in preparing the surface of his roads before oiling.

It is evident however, that a smoother road on the average can and will be secured by the oil mix process than by the surface oiled method, primarily on account of the ability to smooth the surface of the oil mix road under traffic by means of the blade, a process which cannot as a rule be used on surface oiled roads without danger of breaking the crust with resultant necessity of patching and consequent roughening of the surface, though this roughening may be slight when the patching is skillfully done.

Oil.—Most of the work in 1926 in both Oregon and California utilized oil containing from 60% to 70% of asphaltic residue having 80° penetration at 77° F. There was a wide difference in the appearance and behavior of the oils. Tests showed specific viscosity (Engler) at 122° F. ranging from approximately 10 to 100.

60% to 70% oil is called "fuel oil" and that containing a higher percentage of asphalt is "road oil." Fuel oil is less expensive than road oil, easier to apply, and requires less cover, which should encourage its use wherever it will serve the purpose.

The range in viscosity makes possible the division of fuel oil for road purposes into three grades—light, medium, and heavy. The latter has some of the visual characteristics of road oil. For the 1927 program, California has specified a 60% to 70% asphaltic oil, classified according to viscosity (Engler at 122° F.), as follows: light, 10-25; medium, 25-45; heavy, 45-80.

The light grade was used in Oregon last year for the first application and for both applications on more than half of the mileage constructed (Oregon used some 70% to 80% oil for the second application).

Light oil was also used on some sections in California. It penetrates a metaled road readily, but is removed by excessive rainfall. On the Coast Highway in Northern California half or more was washed away during the past winter.

The medium grade of oil will penetrate fairly well and is more stable in the presence of water. It also distributes readily in the mixing process.

The heaviest grade forms a mat on the surface and penetrates but slowly into traffic bound crushed rock or gravel. More screenings are required when it is used in surface treatment than with either of the other grades. It can be used in the mixing process but requires some additional labor, amount undetermined.

The division of the 60%-70% fuel oil into three grades seems to standardize this product in such form that it will serve most purposes in road treatment. If a heavier oil is deemed to have advantages, it would seem advisable to select 80%-90%, 90% to 95% road oil or "E" Grade asphalt. No considerable field appears for 70%-80% road oil.

Cost.—There is not a great deal of difference between the average cost of oiling by the penetration method and the cost by the old mix process, although the cost of specific projects by either method vary widely.

The average cost of oiling some 426 miles by the penetration method during the current year was $1,103 per mile. The minimum cost was $577 per mile on a 6-mile section where only 10 tons of screenings per mile were used for covering the oil. The maximum cost was $1,582 per mile for oiling 125 miles in our District No. I where 0.66 gallons of oil per square yard and 252 tons of screenings per mile were used. An average of 0.585 gal. of oil per square yard was used on the total mileage oiled.

The average cost of oiling 185 miles by the oil mix process during the same period was $1,183 per mile with an average use of 1.32 gal. of oil per square yard. The lowest cost was on a 2.3 mile section where $761 per mile was spent. The most expensive work was in District VIII where the average cost was $1,364 per mile, 1.6 gal. of oil being used per square yard. As stated elsewhere herein, however, the work in District VIII is the best in the State and apparently fully justifies the additional expenditure to secure a first-class job.

The average delivery price paid for over 7,600,000 gal. fuel oil used in California to date during 1927 has been $1.78 per bbl., or $0.04 per gallon. The price at the refinery was $1.29 per bbl. or 0.03 per gallon.

325,600 gal. of road oil used cost $2.46 per bbl. or 0.059 per gallon delivered.

Conclusion.—In conclusion, it may be repeated that no claim to originality is made in connection with the oiling of natural soil or crushed rock or gravel roads with light asphaltic oils.

It is claimed, however, that by following the methods of procedure outlined herein reasonable certainty can be had that roads so constructed on a good foundation will adequately serve even a large volume of traffic for a number of years at a much lower maintenance cost than the expense of maintaining and renewing a rock road with an untreated surface.

There is no doubt but that the uniform success which has attended the bulk of the oiling done in California this year is the result of systematic study and the adoption of uniform and proper methods of construction, accompanied by laboratory advice and control. Too much stress cannot be laid upon the care which should be given any class of oiling work. Care and skill are necessary if satisfactory results are to be secured.

Federal Aid Progress.—Up to Sept. 1, 61,769 miles of Federal Aid highways had been completed, 13,831 miles were under construction, and 2,248 miles were approved for construction.

Bituminous Surfaces for Old Macadam

Practice in New York State Outlined in Paper Presented Before Canadian Good Roads Association

By D. NOONAN
Deputy Highway Commissioner, New York State.

Mountains of stone and gravel have been placed in our older roads, and, while many of these are disintegrating and the stone is being either worn off or carried into the ditches, we have a stupendous investment in what may be termed serviceable macadam and gravel which can be and is being used as a base for relatively inexpensive surfacing and reshaping to take out excessive crown.

To my mind, it is nothing short of criminal to tear up this type of road, which represents an investment of millions of dollars, and replace with a foundation that is less compact or with one that is only attained at much greater expense than is warranted.

Penetration Top Macadam. — While the policy of our department has been to build and reconstruct our main highways with first-class concrete, there are plenty of locations where resurfacing old macadam with penetration asphalt tops is advisable. The State of New York has on its system approximately 10,000 miles of hard-surfaced highways. Of this mileage there are approximately 3,000 miles of first-class concrete. The balance of the mileage is made up of waterbound, bituminous, lower types of concrete, brick, Topeka and other types of pavement, 2,500 miles of which will require reconstructing within a few years.

Last year on one stretch through the Adirondack mountain region, the department reconstructed 25 miles of penetration-top macadam.

I do not know of any type of pavement that has been unjustly condemned more than our penetration-top macadams. This has been due, in a great measure, to either foundation failures or abuses in construction. Improper maintenance, due to frequent and excessive gallonage of surface treatments, causing the surface to shove and creep, has been another cause of unsatisfactory pavements of this type. Many of our old penetration-top macadams were poured by hand with inferior tools and poor workmanship, and in many instances the asphalt was not poured at the proper temperature or had been coked before it was placed.

Penetration macadams are not at all unlike any other type of pavement, in that you cannot start at the top and get a good result. You must start at the subgrade, and all of the materials and workmanship must be of the best in order to insure a pavement that is smooth riding and of lasting qualities. The bulk of the bituminous material used in our penetration tops has been asphalt, and a large proportion of the surface treatment materials has been a cold tar product.

12 in. Bituminous Macadam Preferred.—I do not deem it advisable to build a bituminous macadam road of finished depth less than 12 in. In other words, the foundation course and bottom course must be at least 9 in. in depth before I would consider it advisable to place thereon the 3-in. top which is the minimum depth top that should be placed. I do not deem it advisable to construct a hot-mixed asphaltic top on any foundation other than concrete.

As illustrative of the very difficult conditions under which maintenance as well as construction of highways is effected in the State of New York, the following statement from a paper published in the "Engineering News-Record" of September 1st, written by Thomas H. McDonald, Chief of United States Bureau of Public Roads, Washington, D. C., is illuminating, as the statement is directly applicable to New York State conditions:

"There is a wide range of conditions in this area, a combination of factors is formed that are the most disastrous to our highways. Here are found, together, thermal ranges from 100 deg. F., to 30 deg. below zero; long periods of alternate freezing and thawing; very finely divided subgrade soils; the heaviest traffic, both in weight and number; and rain, snow and ice for long continuing periods. Mix all these elements together and they are warranted to necessitate the most difficult and most expensive road maintenance. Outside of the area described, all of these factors are not found together in any considerable area, or, if found, their degree of 'baldness' is less. Given any type of road, the factors listed form the worst possible combination to be met."

During the year 1926, by department forces we constructed 27 miles of penetration macadam; 25 miles of heavy surface treatment was completed by department forces, exclusive of contract, and comprised two applications of a ½ gal. each of asphalt binder with stone-chip covering.

During the season of 1926, we light surface-treated approximately 2,200 miles of macadam pavement. This treatment consisted in general of the application, with a motor-truck-mounted pressure distributor of approximately 1/5 to ¼ gal. of light tar applied cold, or of asphaltic cut-back oil, per square yard of pavement, immediately covered with a light sprinkling of stone chips or pea gravel. We plan on surface-treating as above all bituminous macadam pavements every few years in order to secure as nearly as possible a waterproof surfacing, restore the seal coat and protect the broken stone, constituting the body of the pavement, somewhat from the direct wear of traffic.

Stone and Bituminous Material.—In building our bituminous macadam by the penetration method, our specifications calls for a top course made up wholly of No. 3 stone. By No. 3 stone, I mean a stone that according to our specifications is retained on a 1½-in. circular ring and passes through a 2¾-in. circular ring. This insures an open top in which the bituminous material can penetrate. After this stone is spread and completely compacted by rolling with a 10-ton roller, the bituminous material is spread over the surface with an approved pressure distributor under pressure of 50 lb. per square inch.

Two gallons of bituminous material "A" is used in the first application. The surface is immediately filled with No. 1 stone. By this I mean stone that will pass through a ¾-in. circular opening but would be retained on a ¼-in. circular opening. This material must be absolutely free of dust.

The surface is again rolled and then the surface No. 1 stone is broomed off the pavement. A seal coat of bituminous material "A" of ¾ gal. is then applied by means of a distributor, the same as was used in the first operation.

The pavement is then covered with No. 1 stone and the rolling operation is continued. During the rolling, the stone should be broomed around to obtain a uniform surface. About one-half of No. 1 stone is then spread over the entire area of the pavement to serve as a wearing carpet.

The broken stone referred to above should consist of clean, dry, durable, sharp, angular fragments of rock of uniform quality throughout, free from thin or elongated pieces, soft or disintegrated stone, dirt or other objectionable features or materials, and when tested according to the standard methods adopted by the American Society of Testing Materials, should indicate a percentage of wear of not more than 5.7.

The bituminous material "A" referred to above is a natural asphalt or petroleum-residuum product. The latter is what we generally use and is a material with specific gravity at 77 deg. F. of not less than 0.99. It shall also be free from water and of a homogeneous solution, penetration varying between 100 and 150, and not more than 4.7 per cent parafine scale should be permitted. All refinements used in the selection, care and preparation of materials and in workmanship add greatly to the degree of smoothness and durability of the resultant pavement and more than offset the slight additional expense and care which may be involved.

Construction Procedure.—Our department has obtained some very excellent results by following this method of procedure in construction. We do

not allow the pouring of asphalt before May 15th or after Oct. 15th. This, to my mind, is an excellent precaution. Pavements poured in the late fall have not been uniformly successful. From my experience, I believe that we should have hot weather for several days at least after the bituminous material is poured into the pavement in order for the pavement to become sealed under traffic and warm weather. Pavements that have been completed late in the season in cold weather take on a rather toothy appearance, and the following season it is necessary to surface-treat them.

During the past twenty or more years, we have successfully used a cold-mix type of asphaltic concrete bituminous macadam surfacing upon ald macadam, commercially known as "Amiesite." During the present season we are laying a considerable mileage of this "Amiesite," using in general a 2-in. finished depth, with admirable results.

During the present season, we are trying out a new cold-mix type of tar concrete bituminous macadam surfacing, commercially known as "Tarvialithic."

In the construction of bituminous macadam pavements, successful results are impossible of attainment unless the most careful attention is given to every detail of material and workmanship. Today the touring public are demanding smooth-riding pavements, regardless of type, insisting upon comfort, just as the general public in the United States under the unprecedented prosperity now prevalent, demand and insist upon all modern improvements which add to their comfort in the home and while en tour, whether via rail, water or highway.

Soil and Winter Conditions.—In the State of New York, soil conditions vary greatly within very short distances. On any short section of highway it is not unusual to encounter water-bearing soil, gravel, clay, sand and rock within a distance of ½ mile.

With further reference to winter conditions: With the growth of the motor traffic to its present stags, there is a demand for continuously clear highways. The snow formerly served as a protective blanket, limiting frost penetration during the period representing more than one-third of the year. By the removal of snow, pavements are now exposed during low temperatures to the untempered weight and friction of fast-moving vehicles, and this while in their most brittle state; and the snow on the sides of the pavement forms a trench which holds surface water during periods of thaw. In other words, the pavement is simply the bed of a canal which, before snow removal was indulged in to its present extent, drained off simultaneously with the thawing of the snow.

A bituminous pavement will withstand the rigorous weather and traffic condition of the winter months exceptionally well, due to its flexibility, and also due to the fact that it is practically a waterproof surface.

1,370 Miles of New Forest Roads Built

A total of 1,370 miles of forest roads was constructed in and adjacent to the national forests of the United States during the past fiscal year, it is announced by the Forest Service, United States Department of Agriculture.

The amount expended on all forest road construction during the year was $7,713,535, of which $6,787,656 was from Federal funds, and the remainder, $925,879, from local co-operative state and county funds. The 1,370 miles of forest roads constructed during the year included 292 miles of major highways, and 1,078 miles of minor roadways. The latter are primarily county and community roads and are for forest protection and development. The major highways were built by the Bureau of Public Roads, while the minor roads were constructed by the Forest Service.

During the same fiscal year 1927, there was expended $946,622 for the construction of 4,987 miles of forest trails.

In addition to the construction work, $1,593,950 was expended on the maintenance of forest roads and trails during the fiscal year, the maintenance work covering a total of 14,594 miles of roads and 50,667 miles of trails.

Up to the close of the last fiscal year there had been completed a total of 13,219 miles of forest roads at a cost of $62,044,158, representing an expenditure of $47,775,034 of Federal funds and $14,269,124 of co-operative funds. The mileage of trails constructed to July 1, 1927, amounted to 31,607, the total expenditure to that date including $6,060,964 of Federal funds and $251,012 of co-operative funds, or a total of $6,311,976.

The desired transportation system for the national forests, as planned for the next ten years, includes a total of 51,268 miles of roads and 110,385 miles of trails. To reconstruct and complete the present unsatisfactory roads and trails in the system and build the proposed new ones will require a total of $177,124,616, exclusive of maintenance.

To the close of the last fiscal year, the financial co-operation in forest road and trail construction furnished by interested states and counties containing national forests has amounted to approximately one-fourth of the amount appropriated from Federal funds. Oregon has contributed the largest amount with $5,059,540, while California is second with $3,075,678. The three states which show the largest mileage of forest roads completed by July 1, 1927, are Oregon, with 2,098.8 miles; Idaho, with 1,672.8 miles; and California, with 1,285.9 miles.

Traffic Surveys Point Out Causes of Sidewalk Congestion

That sidewalk congestion is one of the major aspects of the general problem of traffic control and constitutes an important problem for retail merchants as well is outlined in a report made public by the Albert Russel Erskine Bureau for Street Traffic Research, which has recently completed another intensive traffic survey in San Francisco.

"Sidewalk congestion not only affects every class of street user but has also a very important effect on business, especially that of retail stores," states Miller McClintock, director of the Bureau. "The attactiveness of a retail district depends to a great extent on the convenience and comfort with which shoppers can get from store to store. When this convenience disappears on account of uncomfortable crowding purchasers are inclined to seek other establishments.

"Surveys conducted by the Erskine Bureau, which is endowed in Harvard University by The Studebaker Corporation, have graphically shown the burden our 20 story cities have thrown on sidewalks that have in most cases been designed for 2 story towns.

"The demand for maximum sidewalk space in most cities has reached such a point that every attempt should be made to clear the sidewalks of all obstructions which impede their free use. Free movement is rendered all the more important when it is considered that the inability of pedestrians to clear street intersections rapidly is one of the principle causes for all traffic delay at corners.

"Trolley and light poles, mail boxes, fire and police telephones, the petty merchandising of street hawkers, open elevators and news stands are only a few of many obstructions to free pedestrian movement along sidewalks.

"The amount of obstruction these abuses can cause was illustrated in the findings of the Chicago survey. At State and Madison Sts., where a check showed the passage of 2,000 pedestrians per foot of sidewalk per hour at the maximum flow, 25 per cent of the available sidewalk space was occupied by a news stand.

"That congestion greatly slows the speed of pedestrians movement was brought out in both the Chicago and San Francisco reports. In Chicago pedestrian speed was found to be 3.16 miles per hour on typical State street sidewalks during the free hours of the morning. Congestion reduces this speed to 2.81 miles per hour during the later hours of the day."

Practically all sidewalks are capable of carrying substantially increased loads with efficiency and comfort if freed from unnecessary obstructions, Mr. McClintock's report concludes.

Bonding and Contracting Practices in Highway Construction

Suggested Changes Described in Paper Presented Oct. 4 at 13th Annual Meeting of American Association of State Highway Officials

By WARREN R. NEEL
State Highway Engineer of Georgia

Bonding and contracting practices on highway work have long been a subject of controversy, but all agencies concerned in the question seem finally to agree at least upon one important point, that over expansion of contractors, both large and small, is one of the most injurious cources of trouble in the building of roads. Highway departments say that over expansion has annoyed them through defaulted contracts. Surety companies declare it has caused them staggering losses. Contractors admit that it has ruined hundreds of construction companies, both young and old, that might have developed or maintained themselves as responsible concerns. Having recognized this condition of affairs surety companies, engineers, contractors, and others concerned, have spent several years in trying to pin the responsibility for over expansion or in trying to correct the existing methods.

Engineers have scored the surety companies for bonding irresponsible bidders. Surety companies have charged the contractors of rebating with agents and giving false information to secure a bond. Contractors have censured equipment and material dealers for selling promiscuously, relying on the bond for security. Surety companies are now passing the responsibility back to highway departments, declaring that corporate bonds were never supposed to represent responsibility in the person bonded. Even the banker has aggravated rather than helped the situation. Apparently all of these conceptions are based on some degree of fact, with the result that the construction industry is undermined with false credit.

Disadvantages of Loose Credit.—Loose credit at one time may have been of some value in construction when competition for public projects was purely local, and when bidding pools could be formed by local contractors but in the present day of interstate and country wide competition between contractors, it has become a nuisance. Where the public official once may have felt a need for encouraging the development of new companies, in order to control prices, he now commonly finds it difficult with prices below his own estimate, to place his project with responsible contractors. A number of highway departments, in the last few years, have issued warnings to bidders to study their projects more carefully and not to bid below cost.

At the present time, automatic credit, created primarily by the surety bond, makes it possible for almost any individual without bonafide credit, experience or organization, to bid upon important projects. Having obtained a bond he can buy equipment, practically on a rental basis, and can buy materials on very easy terms. The equipment can then be used as security for the banker who in all his wisdom rarely knows a contractor's true condition. Through such a process as this, the large contractors becomes a giant over night; the little ones grow big in a few hours, and a large number of new ones, destined to certain failure, arrive with each spring letting.

The Irresponsible Contractor.—Many of these individuals have nothing to lose either in capital or reputation. By bidding extremely low, they can secure a contract, collect a few estimates and by neglecting to pay their bills, obtain additional contracts with the funds obtained and by continuing this practice keep ahead for several years when in reality the firm is insolvent. This often keeps responsible contractors from receiving the job as usually the dishonest contractor bids below cost. Even companies that are thoroughly responsible for a reasonable mileage of highway, expand too rapidly and meet disaster. These disasters may cost the state or its individual citizens, exclusive of losses to the sureties, many times the difference between the bid of the concern that got the job and that of a conecrn who could have performed it. We all know these things yet somehow concerns of know irresponsibility continue to receive contracts, which they cannot perform.

The Surety Bond and the Responsible Bidder.—For many years there has been a prevailing tendency among the awarding officials in all branches of government, to assume that anyone supplied with a surety bond was a responsible bidder. Such an assumption was never really justified, but at the present time it is wholly without foundation. The sureties themselves have told us that the corporate bond was never supposed to represent responsibility, but merely that the work would by some means be completed. This is quite a different conception of the bond from that held by legislators, commissioners and the public. It would doubtless be to the interest of everyone concerned, if they were given correct information. Three points in particular should be emphasized; first, that a bidder's ability to furnish a corporate bond is no assurance that he is responsible; second, that the bond does not protect the state against all of the losses incurred by a default; and third, that for the type of protection given, the premium cost is unduly high. Probably half the present rate would be reasonable for the type of a guarantee provided.

In this connection I believe that all surety bonds should carry a clause placing the entire expense including legal service, of collection under bond in case of default on the surety company and such an expense should be a part of the penalty of the bond. This is the practice in the South Carolina Highway Department at the present time.

The Why of Surety Bond Rates.—The opinion of a well known surety company, handling bonds for contractors in Georgia, relative to the high rate of contract bonds is as follows:

"In the first place the General Contractors Association and the various state highway departments have been trying to take the view recently that the rate on contract bonds is too high. I am going to cite a few reasons why the rate is what it is today. It, of course, is interesting to note that the rate on contract bonds has not increased in many years, but as the agitation for a decrease in rate comes forward, the various state departments keep adding to the coverage right along; writing in, first the payment of labor and materials bill, and even in some states including supplies furnished on the job, and a few states even go so far as to include the equipment and rental of the equipment, and it is very easy to see that as they increase the liability under the bond, they cannot expect to decrease the rate.

"We do feel that the solution to the problem is the closer co-operation of the various highway departments, the sureties and the contractors, and a more thorough understanding of the true relationship. The relationship of a surety to the contractor is that of a co-partner-in-fact, he is a co-partner in every sense of the work except the sharing of the profits, and he does share in the losses, if his co-partner is not solvent. If this relationship is to exist as it does, we need a more thoro understanding with our obligee, to which we are a guarantor, and that we be advised of any unforseen difficulties that might arise and that often do arise, and in that way it would let us co-operate with the co-partner to the end that the obligee would be better served, the surety would be better protected and we would be making a step in the direction of a more complete understanding.

"A great many of the people that are always trying to find fault with any business, whether it is banking or surety-ship or the races, feel that there are evils in the particular kind of business up for discussion that should be corrected, and usually there is some merit to the contention, as the state of perfection has not been reached by any business, up to the present time. We all have hopes of improving, but I do feel that the showing of the surety com-

panies for the past ten years can compare very favorably with the showing of any other business in our progress to a general stabilization of economic conditions. The chaos which once existed when personal surety was used guaranteeing performance of contract and the fidelity of individuals, etc., often worked a greater hardship on the individual and the community, which was more detrimental to economic construction than if the state or municipality had been compelled to have suffered the loss. In other words, it was not fundamentally sound. Surety companies started to occupy this place of a financial stabilizer, just as the Government tried to stabilize trade by the making of money and doing away with the old barter and exchange. It was a new field thirty-five years ago, and the progress has been, in my opinion, phenomenal, and with a closer understanding and better co-operation between the two partners and the obligee, I feel sure that all parties and the public would, in the end, be better served."

At the joint conference on bonding practices held in Washington and White Sulphur Springs, W. Va., highway officials, architects, contractors, surety officials and others discussed at length the conditions prevailing in the construction industry. A way to slow down the rapid birth rate of construction companies and their over expansion was suggested. Great hope for co-operative work was expected, but it hinged upon the surety companies, whose underwriting methods were under fire, and came to nothing beyond the development of bidders questionnaires. Some surety companies still refuse to institute adequate investigations. They stand aloof and apparently hostile to any change of underwriting practices. Every effort to secure their co-operation has failed. Therefore, it looks as though the only course that the highway departments can follow is to make their own investigations and determine the responsibility of every contractor who received the job.

Important Changes Taking Place.—Judging by the highway engineers' expression of dissatisfaction with underwriting methods and by the steps already taken to make contractors qualify for their contracts, it is evident that important changes are taking place in contracting practices,—if not in the surety field. These changes, which are noticeable in the Federal Government, as well as in political subdivisions, represent a throwing off of inefficient habits, and the adoption of methods used in the commercial world. Such changes are particularly noticeable in the highway field, where a billion dollar program has been in progress under antiquated rules and habits of a program not a tenth that size. It has been suggested by one prominent highway official that in the case of an experienced contractor making a satisfactory showing of responsibility and working capital, that the bond might very well be waived altogether or that a personal bond guaranteed by a small cash deposit of 10 per cent of the contract, with an assignment of the equipment on the job, would be preferable to some corporate surety bonds.

The desirability of these changes seems to be quite generally recognized, as are conditions in the construction industry, which have been causing an unusual number of defaults. Therefore, the principal needs of the present moment seem to be the formulation of recommended practices, stimulation of interest and a little educational work among those who control the general destinies of the state.

Some doubt has existed in the awarding officials' minds as to whether they could adopt a policy of throwing out an irresponsible bidder who chanced to be low. Generally they have felt a hesitancy in taking such action. In many cases, contrary to the best interests of the state, they have found it necessary to throw out all bids and readvertise, with the road building season fast slipping by. Commissioners have felt they could not justify to the public any award except at the lowest bid, but the taxpayer is apt to become more hostile over torn up roads and detours than he is over the contract price. Judging by the number of states that are making contractors qualify, a decided recession from some of these conceptions is taking place.

Court Decisions Regarding "Responsible" Contractor.—Concerning the legality and even the propriety of awarding a job to any contractor who is not responsible, very clear decisions have been rendered by the courts. Some have gone so far as to imply that an official is derelict in his duty unless he investigates the responsibility of a bidder and refuses the award to anyone found incapable of doing the work.

The Supreme Court of Kansas, in the case of Williams vs. City of Topeka, said:

"We conclude that the word 'responsible' in the phrase 'lowest responsible bidder' was used by the legislators in the sense in which it had long been interpreted by the court and text writers, and must be held to imply skill, judgment and integrity necessary to the faithful performance of the contract, as well as sufficient financial resources and ability."

The Supreme Court of Illinois in the case of People vs. Kent, agreed with the Kansas Court when it rendered the following decision:

"As applied to a bidder who proposes to undertake the performance of the stipulations and conditions of such a contract as this, we regard the terms as including the ability to respond by the discharge of his obligations in accordance with what may be expected or demanded under the terms of the contract.—"

The Supreme Court of the State of Pennsylvania has been very explicit in laying down a definition of what is meant by a responsible bidder and in warning against accepting a surety bond in lieu thereof as evidence of responsibility. It says:

"The term 'lowest responsible bidder' does not mean the lowest bidder in dollars; nor does it mean the board may capriciously select a higher bidder regardless of responsibility or cost.

"What the law requires is the exercise of sound discretion by the directors. They should call to their assistance the means of information at hand to form an intelligent judgment. They should investigate the bidders, to learn their financial standing, reputation, experience, resources, facilities, judgment and efficiency as builders . Giving a bond alone does not make up for responsibility; we have too many bonding companies willing to indemnify almost anything.

From these decisions it appears that an awarding official in many of the states at least is more or less obligated to refuse a contract to concerns which he knows will do dishonest work or fail to carry out their commitments.

Unfortunately in some localities the engineer who attempts to bar dishonest and incompetent contractors from his work is subjected to attack from various business agencies who will profit through an award to some specific contractor. Occasionally they will attempt to discredit him and undermine his position. It is not necessary to state the kind of business in which such attacks originate, but it is only fair to state that from the writer's observation they do not come from responsible contractors. We should recognize that contractors associations, when properly organized, are exerting a beneficial influence by striving to clean house in their industry.

Cooperation of Responsible Contractors.—In fact, a few of the departments have utilized the co-operation of such groups to carry through important measures. The responsible contractors of the country appear eager to co-operate with the departments in correcting abuses within their own ranks, as well as among other elements of the industry. They have expressed themselves in several localities as willing to aid and protect any engineer who is under fire for carrying out his duties.

This point is mentioned here merely to indicate that the efforts of a department to institute a procedure of qualifying to demand high standards of performance, will generally be supported rather opposed by the better class of contractors. Where good highway associations are in operation, they can be utilized in many ways to establish a suitable system.

Investigation of Bidders by State Highway Departments.—As nearly as one may determine from specifications, about half of the state highway departments are favorable to the policy of investigating bidders. Some of them use more or less comprehensive questionnaries which reveal under oath his qualifications for each job and which he must submit before receiving an award. Among these states which make the bidder show his experience and financial standing are: New Mexico, Florida, Pennsylvania, Ohio, Kentucky, Wisconsin, Missouri, Georgia, Nebraska, Iowa, Delaware and Illinois.

The state of Kentucky particularly appears to have developed a thorough system of investigation, using therein the standard questionnaries approved by the American Association of State Highway Officials in 1926. Under its plan each bidder is required to file a sworn statement showing his financial condition, amount, condition and value of his road building equipment and his experience record. A plan and equipment questionnaire must be filed with each and every proposal submitted. The financial and experience questionnaire must be filed with the first proposal submitted by a contractor and renewed once each six months thereafter or more often if requested.

The Missouri Department requires that the financial statement shall be as of a date not more than 30 days prior to receipt of bids. Iowa requires that any contractor who has not before completed a paving contract on the primary road system under direction of the State Highway Commission, must submit his qualifications at least five days before a letting. He is then advised how many miles the Commission is willing to award him if he should be low.

Wisconsin has a plan somewhat like that of Iowa, but extending the basic principle much farther. Every bidder is investigated in advance of receiving proposals, and listed in accordance with the size of project that the department would award him. Continued check upon each contractor's operations is made by reports from the field and each is known to the department by the character of his performance. It would be interesting to hear from the Wisconsin officials something of the details of their system and how satisfactorily it works in actual practice.

On the surface, that system seems to have a number of advantages over procedure in other states, which in theory at least would have a very beneficial effect upon present conditions. The department is not confronted with the necessity of throwing out the low bids of contractors that are incompetent or dishonest, because each bidder must have demonstrated his responsibility before his proposal is considered. Thus the disagreeable reaction to skipping bids would seem to be avoided. More important, however, is the tendency of the system to check over expansion of both large and small concerns and have them keep within the limits of work which can be handled successfully by their organizations.

The Danger of Over Extension by Contractors.—Strange as it may seem, many sizeable construction companies do not know what amount of work represents their limitations, and consequently become irresponsible by taking on too much. We sometimes fail to recognize that the term "Responsible Contractor" has hardly any meaning with respect to size, except when considered in connection with a specific project and with the total volume of his work on hand. Every contractor, whether large or small, has a limit of work which he is competent to handle with his organization, capital, equipment and experience. The heaviest individual losses, so the surety officials say, come from the big concerns that have over extended. Since the contracting industry does not seem able to curb its own over expansion, the highway departments in self-defense will probably have to do so.

Interest in the subject of qualifying contractors is not confined to the highway field. The same tendency is noticeable in counties, municipalities, and the Federal Government. Private consulting engineers are using the standard questionnaires approved by this association. These agencies combined have obtained from the Joint Conference on Construction Practices, which developed the questionnaires, some fifteen thousand sets, which in many cases were used as copy for reproduction in quantity. Evidently the idea has appealed strongly to officials in charge of all types of public construction.

It begins to look as though within a few years, the qualifying and rating of contractors by some suitable procedure might become a universal policy. If this should occur, it is highly important in the interest of efficiency and economy, that some sort of recommended practice be developed.

Individual construction companies are bidding in many states at the present time, and some degree of standardization is particularly desirable when departments desire to exchange information on bidders. This is particularly true with respect to financial statements. Preparation of bona fide financial statement is a rather expensive and troublesome thing, if properly done; and a correct statement made annually under oath ought to be satisfactory in any state where a bidder may be required to use it. The forms approved by this association have had the most careful study by bankers, surety officials, contractors and engineers. They have been approved and are being used by members of the Clearing House Section of the American Bankers Association. Therefore, it is suggested that they be used by the Highway Departments as nearly as possible in their present form.

The standard financial statement was particularly designed to encourage intelligent bookkeeping among contractors, and if it accomplishes nothing more, it will help them to overcome the most serious fault of their industry. The public will also benefit from that. If anyone considers the form too voluminous, he can readily delete without destroying the general plan. However, it should be remembered that the average financial statement can be so deceptive as to be of little value. If a statement is to be used, it should not be of such a form as to permit gross deception.

Possibly the entire procedure of investigation could be standardized and the information so kept that any State Department could readily check up the responsibility of bidders from other states. It is conceivable that in the future some central agency might take over the information collected and maintain it for the general benefit of public bodies and the commercial world. Some such a plan was hopefully proposed to the surety companies at the joint conference, but the proposition was rejected.

In any event it appears that sentiment is crystallizing into a conviction that public construction should not be the training and experimenting ground for contractors, and that they must present some degree of responsibility before taking public contracts. If this is true, it means that some kind of practicable procedure for qualifying must be developed.

Suggestions for Procedure for Qualifying Contractors.—As a step in developing something of this sort, specific suggestions on the subject are here offered for discussion with the hope that the American Association of State Highway Officials will lead the way to more satisfactory contracting procedure by enunciating recommended practice. The suggestions are as follows:

1. Bidders should be required to show their qualifications for each specific project before they are awarded a contract.

2. The standard questionnaires should be used with such deletions as the department desires to make, for gauging a contractor's character, experience, financial standing and plan of operation.

3. In using the questionnaires for qualifying after proposals are opened, the following procedure should prevail.

(a) The experience questionnaire to be submitted by every bidder who has not already submitted it within the year preceding the letting, and to be retained permanently by the department.

(b) The financial statement to be submitted by every bidder who has not already submitted one within the year preceding the letting, and to be as of a date not prior to one year before the letting. The low bidder should be required to submit a financial statement as of a date not prior to sixty days before the letting. His statement should be retained indefinitely, if he is disqualified or defaults his contracts, but should be returned to him upon conclusion of the work, if he completes his contract.

(c) The plan and equipment questionnaire should be submitted with each proposal and retained under the same condition as the financial statement.

3-A. In using the questionnaires for qualifying and rating before proposals are opened, the following procedure should prevail:

(a) Any bidder desiring to do state highway work must be on the department's qualified list 48 hours before the time set for opening of proposals.

(b) Any bidder desiring to be on the qualified list shall submit the experience questionnaire and the financial statement thirty days in advance of the letting, if he has not before completed a contract for the Department and seven days in advance if he has completed a contract.

(c) The plan and equipment questionnaire to be submitted with each proposal.

(d) All questionnaires and state-

ments should be retained by the department.

(e) Each bidder should be given a rating on the qualified list indicating what amount of work he will be awarded, if low.

4. All qualifying information received from contractors should be carefully protected and made available only to those in the service of the department, whose personal duty it is to do the qualifying, and possibly to surety companies.

5. Information on defaults should be made available to all state highway department, and surety companies and some method should be worked out where the individuals composing defaulted firms, and sometimes corporations, organized under a different name, should not be permitted to bid on new work.

It is not presumed that the suggestions here made are entirely suitable to present needs. They are made for the purpose of discussion, but with the hope that the association will give them serious study and formulate some recommended practice.

Errors to Avoid in City Planning

Paper Presented at Dallas Meeting of American Society of Municipal Improvements

By GUY WILFRID HAYLER

Planning Engineer, Regional Plan Association, Inc., for San Francisco Bay Counties, California

Errors in city planning may be said to be progressive and they first start with the instrument which sets out to do city planning. One must recognize the virtual impossibility of being able to foresee every danger of a mistake, but at the same time city planning has now accumulated at least twenty years' experience in administrative working in America and it should be possible to guard against the errors into which various municipalities have fallen.

Each great city is a problem entirely of its own. There are some 30 great cities in America and it is conceivable that there can be easily 30 ways in which their planning difficulties may be attacked, and yet all of these ways are reasonably different. The great city is the abnormality in cities. The large mass of cities are small or medium-sized and general discussion of city planning must have them in mind as the average cities to consider. It is always unwise to copy great city methods in small cities, yet the local people are very susceptable to imitation in this respect. What New York, Chicago, Philadelphia or other metropolitan areas have done or can do in the way of civic improvement is of very little help to the small city and often of doubtful advantage.

City Planning Body.—The desirable areas where homes should be or vice versa, major traffic arteries running city planning body for a small city has been a matter of controversy in city planning circles but it is imperative that this question be solved at the start. Presuming that the Commission is officially appointed, on the request of some such body as a Chamber of Commerce, the latter should study the type of body, composition and powers it should possess, so that the governing body may have this information for guidance. If this was done with the assistance of professional city planning consultants, much confusion and disappointment would be avoided. It might also be possible to submit a list of names of men and women sufficiently informed on city planning to prove useful members of such a commission.

A small commission is generally more preferable to a large one and much more likely to get somewhere with the work. The trend of municipal government is unquestionably towards a centralized form as giving the greatest efficiency and ease of working. It therefore seems only logical that if the city planning policy be given into the hands of a small body, an equally satisfactory result will ensue. It should also be arranged that larger unofficial bodies taking up different phases of planning thrash out the knotty points and come into consultation with the official commission for the final decisions. This procedure will greatly diminish the unseemly quarrels which so frequently are aired in the commission and leave them free for quiet deliberative work. Under such circumstances a commission of 5 or 7 members would amply suffice.

Initial Survey.—The first work of the commission should be the making of a really informative survey of local conditions, with complete maps and statistics. One of the greatest errors a commission can fall into is the plunging into planning without such a survey. This is the key to the whole situation and without it nothing can be satisfactorily done.

The City Plan.—The second work should be the drawing up of a comprehensive city plan covering all features of improvement work and arranged so that they may be carried out progressively. The present craze of cities making zoning plans ahead of city plans is absolutely illogical and almost certain to lead to trouble later on when city improvements are proposed. Zoning can only be properly done when the future of the city has been studied, property conditions can not be stabilized on any other basis. The error most common, is that of building up a permanent structure on what is now existing and making very frequently temporary objectionable conditions into almost irremovable conditions. This may occur with residential areas badly located, industrial through residential areas imperilling homes, schools, etc., and a host of other possibilities. Finality in zoning should be one of the last phases of planning procedure, rather than the first.

Stabilizing Ordinance.—The advantages of zoning can be satisfactorily secured at the time the comprehensive city plan is first taken up by passing a blanket ordinance stabilizing the present conditions of property use in the city until the final zoning is worked out. All new building construction which infringes these conditions will then be required to have the approval of the city planning commission who can thus prevent land exploitation and the raising of serious obstacles to future public improvements.

The point to bear in mind is that zoning laws, like traffic laws are largely regulatory and administrative, and in both cases the physical network of the city must receive attention before you can do much more than make a palliative solution to your problem. Then again it would be a much wiser approach to both the zoning and traffic questions if they were under distinct city commissions apart from city planning—at least in the larger cities. Aside from the fact that they both concern streets, they have little in common with constructive planning. Ordinances governing their operations can be and are made and unmade at very frequent intervals and are dependent upon streets and buildings which cannot be changed unless at enormous cost over long periods of time.

Hitherto our cities have been governed from an individualist standpoint with the smallest infringements on personal liberty. City planning, with all its good points, is essentially at variance with this doctrine. Education must come first to convert the average citizen to the viewpoint of the community rather than personal interests. Civilization is too complex to consider anything but the welfare of the mass and we shall be, not only sensible, but indeed fortunate, if we can come together more and more outside the strong arm of the law, to not only preserve city amenities but safeguard them for our successors.

Holmes Resigns from Montana Commission

Howard W. Holmes, state highway engineer since 1923, tendered his resignation to the Montana Highway Commission last month. The resignation was accepted by the commission, and Ralph Rader, construction engineer, named as Mr. Holmes' successor. Mr. Holmes gave as his reason for resigning the development of an opportunity to become established in his own business. He will become identified with a road and bridge building business, with headquarters at Helena.

Pavement Widths

Recommended for Streets in Chicago Region by Chicago Regional Planning Association

Thirty years ago the average street vehicle required a lane only 7 or 8 ft. wide in which to move with ease and safety. Since then, however, highway travel has been revolutionized; vehicles have increased in numbers, move faster and are made wider, yet many municipalities have failed to change their width standards when building new pavements. One reason for this can be attributed to the force or precedence that past practice exerts upon new work. Another is the lack of a new standard for property owners and village or city officials to follow when preparing paving petitions and ordinances.

To provide such a set of width standards is the following summary and recommendations have been prepared by the committee on highways of the Chicago Regional Planning Association. The standards represent the combined opinion of many engineers and officials of the region and members of the committe on highways of the Chicago Regional Planning Association and also conform to standards now in use throughout the United States.

Recommendations

Lane Widths. — The recommended lane widths or unit dimensions which, when combined, form total widths, are as follows:

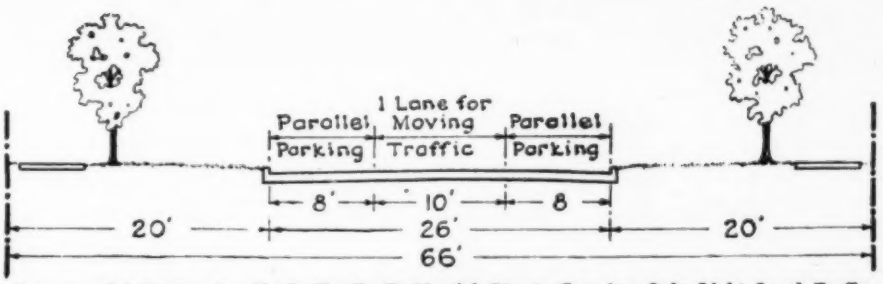
A. Lane for moving traffic.....10 ft.
B. Lane for parking parallel to curb ..... 8 ft.
C. Lane for parking at angle with curb .....18 ft.

The lane widths above are believed to be minimum for safety and free movement of traffic under all conditions; light, darkness, rain, snow, ice and dry weather. They are also considered maximum because a slightly wider lane invites the crowding in of another vehicle which is dangerous.

Diagonal Parking.—Parking at an angle on main thoroughfares is not generally recommended except where the pavement is wider than is necessary for moving traffic. The dimension given is capable of being converted into two lanes, a 10 ft. lane for moving traffic, and an 8 ft. lane for parallel parking.

Clearance. — State laws generally limit the width of vehicles to 96 in. or 8 ft., and there are many trucks and busses which approach this dimension. While the average passenger car is only about 6 ft. wide, it requires greater clearance for safety and free movement under all weather conditions than the wider, slower moving truck.

Odd Number of Lanes.—Unless properly regulated an odd number of lanes for moving traffic on major streets is believed to be unsafe because the di-

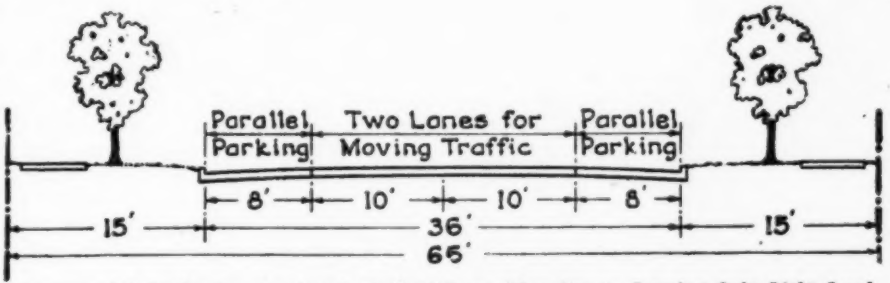


Recommended Section for Single Family Residential Streets Carrying Only Light Local Traffic and Having Parallel Parking

26 foot pavement provides:
1. 1 lane for moving traffic, 10 feet wide.
2. 2 lanes for parked cars, each 8 feet wide.

This width is recommended as minimum for single family residential streets carrying very light local traffic only. Although 26 feet allows only one lane for moving traffic, ordinarily two cars can pass by one turning into an unoccupied section of a parking lane.

Fire departments often object to pavements this narrow but if corners are well rounded, curb radii not less than 20 feet, they should experience no difficulty in moving their apparatus, provided there is not too much parking.

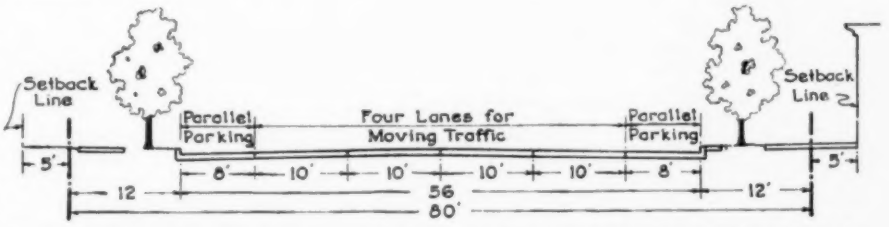


Recommended Section for Apartment, Residential, or Other Streets Carrying Only Light Local Traffic and Having Parallel Parking

36 ft. pavement provides:
1. 2 lanes for moving traffic, each 10 ft. wide.
2. 2 lanes for parked cars, each 8 ft. wide.

This width is recommended as minimum for apartment and residential streets carrying light and local traffic only.

For a local business street a 36 ft. pavement may cause congestion with resulting inconvenience and danger to shoppers. When business begins to locate on a 66 ft. street a building setback line should provide for at least an 80 ft. width so that a wider pavement may be built when traffic demands.



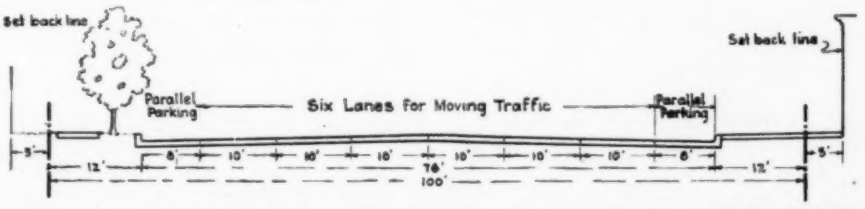
Recommended Section for Business or Other Streets Carrying Very Dense Traffic and Having Parallel Parking

76 ft. pavement provides:
1. 6 lanes for moving traffic, each 10 ft. wide.
2. 2 lanes for parked cars, each 8 ft. wide.

Where traffic is very dense this width is recommended for:
1. Business streets.
2. Streets connecting business centers.
3. Streets connecting with heavily traveled state or county highways.
4. Double street car line streets. (Outside width of two street cars is about 20 ft.)

In business districts sidewalks can be made wider than 12 ft. by requiring the 5 ft. setbacks recommended in the Association's subdivision Ordinance.

Streets which need a 76 ft. pavement and are not now 100 ft. wide should be widened.



Recommended Section for Business or Other Street Carrying Dense Traffic and Having Parallel Parking

56 ft. pavement provides:
1. 4 lanes for moving traffic, each 10 ft. wide.
2. 2 lanes for parked cars, each 8 ft. wide.

This width is recommended as minimum for:
1. Business streets.
2. Streets connecting business centers.
3. Double street car line streets. (Outside width of two street cars about 20 ft.)

In business districts sidewalks can be made wider than 12 ft. by requiring the 5 ft. setbacks recommended in the Association's Subdivision Ordinance.

Streets which need a 56 ft. pavement and are not now 80 ft. wide should be widened.

rection of travel in the center lane is too often in dispute and is therefore the cause of accidents.

Street Cars.—Where street cars occupy space in the vehicle roadway, lane widths should be figured from the outside edge of the street cars.

Total Pavement Widths.—The total roadway widths recommended are 26, 36, 56 and 76 ft. and are shown in detail in the illustration. The width of pavement to build on any particular street can be determined from the discussion and notes which accompany each cross section.

Personnel of Committee.—The Committee on Highways of the Chicago Regional Planning Association consists of the following:

Chairman, Marshall E. Keig, Vice-Pres., Consumers Company; J. R. Blackhall, Vice-Pres., Chicago and Joliet Electric Ry.; Andrew Christensen, Engr., Chicago, Milwaukee and North Shore Ry.; George W. Craig, Dist. Engr., Asphalt Association; William G. Edens, Illinois Highway Improvement Association; F. E. Ertsman, Illinois State Automobile Association; E. L. Gates, DuPage County Superintendent of Highways; N. M. Griffin, Vice-Pres., Mack International Truck Corp.; Claude Hanson, Kane County Superintendent of Highways; John B. Hittell, Chief Engr. of Streets, Chicago Board of Local Improvements; G. N. Lamb, List. Eng., Illinois Division of Highways; Olaf Langeley, North Twp. Good Roads Committee, Lake County, Indiana; R. R. Leffler, Eng., Sanitary District of Chicago; R. M. Lobdell, Lake County (Ill.) Superintendent of Highways; E. J. McIlraith, Eng., Chicago Surface Lines; George A. Quinlan, Cook County Superintendent of Highways; Frank T. Sheets, Chief Highway Engr., Illinois Division of Highways; Will H. Smith, Will County Superintendent of Highways; Peter S. Theurer, Motor Truck Division, Ill. State Auto. Assn.; Wm. J. Titus, Chief Engr., Indiana State Highway Commission; James T. Voshell, Dist. Eng., U. S. Bureau of Public Roads; C. K. Wallace, Lake County (Ind.) Surveyor; C. Weymouth, Deputy State Hwy. Engr., Wisconsin Highway Commission; Hugh E. Young, Chief Engr., Chicago Plan Commission.

North Carolina Taking Road Bids

Bids were received by the North Carolina State Highway Commission Dec. 13 on approximately $1,700,000 worth of work which includes the construction of 48.51 miles of hardsurface, 65.29 miles of dirt road, and several structures. The roads are scattered throughout 15 counties, and divided into 16 projects.

Coolidge Advocates Latin-American Roads: International Highway Is Given Impetus

President Coolidge on Dec. 6 advocated assistance to the construction of Latin-American highways connecting with the United States, according to an interpretation of the President's message to Congress by the American Road Builders' Association.

"Authority should be given by law to provide these countries at their request with engineering advisers for construction of roads and bridges." The President said, "Private interests should look with favor on all reasonable loans sought by these countries to open such main lines of travel."

According to Charles M. Upham, Director of the American Road Builders' Association, President Coolidge's message is a distinct approval of the contemplated international highway extending from Canada to South America.

Plans for this highway will be discussed during a session of road builders from Latin-American countries to be held in Cleveland in connection with the road builders' convention during the week of January 9th. The sessions will be held on January 12th, which will be designated as Pan-American Day.

Twenty-two nations have been invited to participate in the road congress. Several nations have already accepted, and will send official delegates to take part in the sessions. An honorary chairman will be named from one of the participating countries by Charles M. Babcock, president of the American Road Builders' Association and Chairman of the Minnesota State Highway Commission.

The international highway movement was taken up by the American Road Builders' Association many years ago. Active promotion on the project, however, was held up until three years ago. At this time a meeting of Pan-American highway officials was held by the road builders in Chicago, and once more the highway plans were discussed.

Iowa Lets Paving Contracts

More than three million dollars' worth of paving, graveling and bridge construction contracts have been awarded during a recent week by the Iowa State Highway Commission.

The paving contracts awarded on one day called for 12.313 miles in Mills county and 23.556 miles in Page county. Contracts for paving let during the previous day aggregated 68.084 miles, costing $1,765,833.85. The paving was divided among five counties—Buchanan, 8.049 miles; Butler, 19.468 miles; Delaware, 23.778 miles; Pottawattamie, 5.189 miles, and Wapello, 11.6 miles.

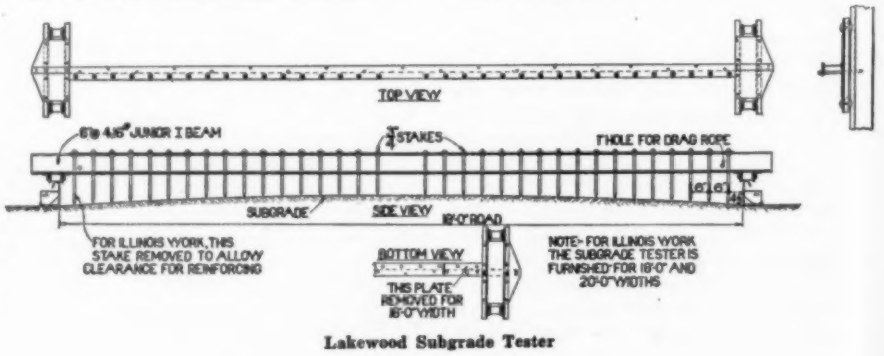
Graveling contracts let on the second day are for 5.66 miles in Clayton county on primary road 13, and 2.2 miles in Montana county on primary 37. Graveling totaling 29.937 miles in four counties was contracted for on the previous day at a cost of $25,497.71. Crawford county had 7.2 miles; Floyd 10 miles; Worth 3 miles, and Wright 9.737 miles.

Awards for bridge and culvert construction are in Henry, Madison and Worth counties. The first day's bridge lettings called for $126,357 worth of bridge contracts. They call for construction of one bridge over the Des Moines river in Boone on U. S. highway 30; one bridge and 50 culverts in Iowa county; one bridge and 19 culverts in O'Brien county; and widening of one bridge and one culvert in Pottawattamie county.

Average price per mile for hard surface paving contracted for ranged from approximately $24,300 to $28,049. The price per square yard ranged from $2.13 to $2.43.

New Subgrade Tester

The accompanying illustration shows a subgrade tester made by the Lakewood Engineering Co., Cleveland, O. This is in accordance with the standards recently adopted by the Pennsylvania State Highway Department. It is used to check the subgrade just before the concrete slab is placed. A particular feature is that it is adjustable for two widths, either 16-18-ft. or for 18-20-ft. roads. The pins may be set to any desired cross section.


TOP VIEW
6"@ 4.15" JUNIOR I BEAM
STAKES
HOLE FOR DRAG ROPE
SUBGRADE
SIDE VIEW
18'-0" ROAD
FOR ILLINOIS WORK, THIS STAKE REMOVED TO ALLOW CLEARANCE FOR REINFORCING
BOTTOM VIEW
THIS PLATE REMOVED FOR 16'-0" WIDTH
NOTE- FOR ILLINOIS WORK THE SUBGRADE TESTER IS FURNISHED FOR 16'-0" AND 20'-0" WIDTHS

Lakewood Subgrade Tester

Personnel Selection and Training

Opportunities in the Highway Grading Field Described in Paper Presented Oct. 5, at 13th Annual Meeting of American Association of State Highway Officials

By T. WARREN ALLEN
Chief, Division of Control, Bureau of Public Roads

The quality of organization performance is governed by the ability of its personnel. It therefore seems plain that those who are responsible for the conduct of an organization should do the utmost to attain an ever-increasing fitness in personnel. This, in the case of recruits, can be accomplished by securing men of the very best type with the very best education, and then training them adequately prior to detailing them to the regular work of the organization. The training of existing personnel is even more necessary than securing first-class men as entrants. These are the men on whom the executive must depend for assistance in carrying on the work entrusted to his care, and whatever can be done to stimulate their interest and broaden their outlook will be well worth what it may cost.

In every kind of business activity the tendency is toward a higher plane. There is a constant striving, whetted by competition, for more efficient performance. The engineer, too, must realize that his position in society requires constant effort to improve his professional standing if he is to maintain the "status quo," and if he is to raise his relative position the effort must be supreme.

To raise the standard of the engineering profession it will be necessary to raise the standards of its work and the conception of its duties. I believe the possibilities of accomplishing this are excellent. I believe all branches of the profession offer opportunities, but in this paper I shall make reference to some of those in the highway grading field only.

Effect of Grade Laying on Cost of Haul.—As a simple illustration in the field of haul length, take the matter of grade laying. Given a limiting per cent, a person of ordinary intelligence can lay down a grade so as to balance cuts and fills, but how many are there that concurrently take into consideration the effect of haul length as it affects the amount it will cost a contractor to do the grading, or who appreciate fully the extent to which the hauls fixed by each design control not only the actual cost of performing the work, but also very frequently fix rather definitely the equipment with which the work can be done at the lowest cost. A higher conception of what may be done in this instance would raise this detail above the reach of men of only ordinary intelligence.

Everybody, of course, knows that the cost of moving material varies with the length of haul, but as applied to the cost of completing the ordinary grading job the rate of such variation is not always so clear. Neither the rather common criterion of the average length of haul, nor that of the total cubic-yard-stations of haul are always a correct measure of which of two designs will actually cost the least to construct, even though the total yardage be the same in both cases with cuts and fills fully balanced.

There are two reasons for this. In the first place, the cost of hauling as met with on our everyday grading projects does not increase at the same rate as the distance. On all short-haul work the time required for taking on the load, dumping it, turning, maneuvering, etc., forms a rather large percentage of the total round-trip time. On very long hauls, however, this standing time factor generally becomes almost negligible.

How Widely Varying Lengths of Haul Affect Cost.—The second reason, however, is usually the most important and the one which seems most frequently neglected in our designs. This is the effect of widely varying lengths of haul on the actual cost of doing the work, especially when the elevating grader or the power shovel is employed. Both of these implements are alike in that, except where casting is possible, neither can dig any more material than can be handled effectively by the hauling units. Furthermore, their production can not be increased beyond a definite rate by adding more hauling equipment. They are the primary producers to which the hauling equipment must be adapted if a high rate of efficiency and low unit costs are to be secured.

But under any given set of conditions, the number of hauling units of any given kind required to maintain full production at the shovel or grader depends largely on the length of haul. Now, if the design is such that the hauls from each of the several cuts are somewhat nearly equal, the contractor can readily determine the number of hauling units he will need to keep and maintain the desired rate of production. If the hauls are uniformly long, the number of hauling units will, of course, be larger than if the hauls are all short. But, in either case, there is a definite number of units which can be kept reasonably busy throughout the contract, a number which the contractor can generally determine with a reasonable degree of accuracy. Any excess or shortage is readily apparent and can be easily remedied.

On a job which involves hauls of widely varying lengths and especially one on which these hauls fluctuate frequently and irregularly, as is so often the case, the contractor faces an entirely different set of conditions. On a job of this kind it is seldom practical for the contractor to vary his hauling equipment in accordance with the demands of the haul, which may be 100 ft. this morning and 1,000 ft. by night. If he brings to the job enough equipment for the long hauls, a very large proportion will be idle on the short hauls, and idle hauling equipment on the job means money out of the pocket. On the other hand, only enough hauling units for the short hauls will force the shovel to be idle much of the time when the long hauls occur, which is disastrous to his profits. Now, anyone who has given thought to these questions will admit that no matter how the contractor arranges his hauling equipment a job of this nature is going to be unreasonably expensive.

What Happens When Haul Lengths Are Increased.—Insufficient consideration of haul lengths at the time of making the design is the reason why requests are received later on from the contractor to borrow and waste, with pay for contract quantities only. They ask this because, if permitted to do it, they will save money for themselves. Do you not think the engineer should foresee its wisdom and provide for it in his plans, so that competitive bidding may be on that basis?

Under average power shovel work increasing the haul from 500 ft. to 1,200 ft. doubles the hauling cost per cubic yard for team-hauled excavation. And this is not the only drawback to increased haul. Team and wagon haul on work of this sort generally is cheaper up to a distance of about 500 ft., and from that point on other means are cheaper. So that by using hauls of various lengths, running from very short up to very long, you not only preclude the contractor from efficiently adjusting the size of his hauling outfit to the work to be done, but you also saddle him with a condition where, if he uses teams and wagons, his hauling costs are excessive above, say, 500 ft., and if he provides only hauling equipment which is economical above 500 ft., his hauling costs are excessive below that limit. If he provides both kinds of hauling equipment, his carrying charges will be excessive.

Effect of Kind, Character and Condition of Material on Shovel Excavation.—Each grading job has, in general, certain more or less typical features which ear-mark it, so to speak, for a particular type of equipment. It is the duty of the designing engineer to take cognizance of these natural advantages and develop them in the same manner that he develops his other economic factors, to the full extent of their possibilities in his final layout.

In good, common excavation a ¾ cu. yd. power shovel in good condition, and in the hands of a skilled operator, has been found capable of loading wagons or trucks at the rate of four well-filled dipper loads per minute, providing the swing does not exceed 90 degrees. Instances have been found where this rate has been maintained for as long as one hour, but the all-day rate for a good operator under the same conditions appears to be about three well-filled dipper loads per minute, or 180 dipper loads per hour.

But, if in the same material and under the same conditions, the swing is increased to 180 degrees—that is, loading behind the shovel instead of at the side—then about the best we can expect for an all-day rate is two and one-half dipper loads per minute, or 150 dipper loads per hour. Some slow-swing shovels can not be expected to yield much over two dipper loads per minute on a 180 degree swing. A narrow grade where the loading must be at the rear, with an average swing of 180 degrees or more, may, therefore, be expected to show considerably higher unit prices than grades wide enough to permit loading at the side.

The kind, character and condition of the material all have an effect on both the rate at which the shovel can operate and the amount of material handled per dipper load. However, where proper blasting is done and the angle does not exceed 90 degrees, there are comparatively few occasions when a good operator can not handle an average of two dipper loads per minute. Tough adhesive materials, which stick or hang badly in the dipper, are perhaps the slowest to handle.

But production is the product of the number of dipper loads multiplied by the average amount moved per dipper load. In ordinary excavation the usual ¾ cu. yd. dipper load can be expected to average about ½ cu. yd. of material as measured in place, providing the cut is not less than 3 ft. deep. Very shallow cutting is almost sure to yield considerably smaller dipper loads. This is also true of materials intermixed with roots and certain tough clays which cut in slices. Solid rock and shale, if well blasted, should average about 0.4 cu. yd. per dipper load as measured in place. Poorly blasted rock, however, may readily run as low as 0.3 cu. yd. per dipper load. Handling this kind of material is always expensive, for it is hard on both the shovel and the wagons; much time is consumed in loading the dipper and dumping is slow, as considerable care must be taken to prevent too serious injury to the hauling equipment, while large pieces frequently stick or hang in the dipper.

Two items here are of special interest to the engineer; first, that some adhesive clays may prove as expensive for the contractor to handle as ordinary solid rock; and, second, that the extra cost of handling solid rock is very largely dependent on how thoroughly and at what cost it can be drilled and blasted. Ground which is difficult to shoot properly should be avoided as much as possible in fixing the location. Bureau studies of these things are throwing some light on the troublesome problem of classification. They are indicating the relative cost of excavating different materials. A definite settlement of this matter will result in eliminating from contract work some of the gamble, will reduce lawsuits which, in the aggregate, cost a considerable amount, and will ultimately secure lower bid prices.

But the principles involved here are not limited to just grading and the location layout. They apply equally well to practically all lines of highway work. For example, how many of us give any thought as to whether some design, which we believe to be best theoretically, can be built in just that way. For instance, many pavement designs call for a thickened edge running out at about 3 ft. from the pavement edge, with a well-defined angle at the junction. This calls for subgrade construction, which the contractor can not very well build just as designed and properly consolidate it, and usually results in rolling off the angles where the thickening begins and using a surplus of concrete at this point, which amounts to a considerable in the aggregate, but for which the contractor receives no pay, unless he increased his bid prices to cover such a contingency.

More and Better Thought Needed.—To me these, and other similar items which could be enumerated, mean that we need to come out of our trance and give more and better thought to these problems. The executive, as a rule, carries so heavy a load that he has no time, even if desirable, to spend on details. It is his duty to formulate policies and indicate the problems he wants solved, and it should be the duty of his assistants to devise the ways in which the work may best be done and recommend the proper procedure for action of the chief. We need to recruit our forces with men of the very highest type that we may have men better able to assist in the determination and solution of difficult problems. The man who with but ordinary education is a laborer today, axeman tomorrow, a chainman, a rodman, a levelman, a transitman, a chief of party, a resident engineer, and so on up in succeeding days, is not the individual we should have. We need graduated civil engineers—not the ones who barely make it, but those of the "cum laude" class. You hear it said that the man who graduates at the top of his class is not the man who can make the most of himself in life. I do not believe it. With equal training and opportunities following graduation, give me the top man. We must get the best men and train them to constantly increasing fitness.

With the construction of the considerable mileage of highways in the last few years, there has followed a wonderful development in nearly all our industries. Our present prosperity is almost inconceivable. We have grown to such an extent that the standards we have been accustomed to in measuring our stature are out of date. The railroads are carrying an enormous traffic, which continues. The enormous business we are doing is normal. It only seems abnormal when measured by the old standards, which are no longer reliable.

In my opinion, this great prosperity is dependent on the improvement and proper maintenance of our highway systems. What do you imagine would happen if in some manner 90 per cent of the improvements on our highways should disappear overnight. If, as I believe, our prosperity is so largely dependent on our transportation system, the State highway departments and the Bureau of Public Roads are facing a responsibility that is tremendous, and one for which we must fit ourselves if we are properly to carry it. It is our duty to do what we can to prevent the strangulation or even the retardation of growth and prosperity which will follow wherever there is insufficient transportation.

The Engineering Turnover in State Highway Departments.—An inquiry elicited the information that the annual engineering turnover in the state highway departments is from 5 to 8 per cent, except in states addicted to political upheavals. The method used in the selection of men to take the place of those leaving is fairly uniform, and where there is no State civil service body selection is usually made from a file of those making application for positions. This procedure puts the State in the position of replenishing its personnel from those who want jobs rather than from those best fitted. Nine states only have civil service commissions. Some of the states make requests of educational institutions within the state for recommended graduates. This may or may not insure a good class of men. There is a tendency on the part of some colleges to recommend the men who need money rather than those who are the best qualified. Again, there are many commercial firms who have agents who visit the colleges just prior to gradua-

tion time and seek to employ the best men. The result is a depleted list for those unable to pay the best salaries. It is my belief that better men could be secured if each organization would require its personnel chief to keep a roster by classes of engineering students in the colleges within the state which would show names, ages, residence and rating by terms, when available at the college registrar's office. A record of campus and society activities would also assist in forming an estimate of a man's capabilities. With such a record available at all times, the selection of capable men as entrants might be arranged for considerably in advance of graduation. Following appointment a period of training should prove advantageous.

In many of the states annual road schools are conducted. These provide for a meeting of a certain number of an organization for a period of one or two weeks, at which time road topics of interest are discussed. These meetings undoubtedly are of value, but the interest developed is rather short-lived. I believe they would be of much more benefit if supplemented by an organized move to stimulate continuous interest.

The importance of securing and training the personnel which will adequately conduct the activities of an organization seems to me to be so vital that a committee of this body might well be designated to give it a thorough study. The value of well-trained men is recognized by commercial organizations, and many of them have a special department to handle it. There has been much said and printed about it. It is a very live subject. In industry, where competition is keen, faults in organization and organization personnel bring immediate results. If uncorrected, they tend toward failure. In public works the results are similar, but the old saying is, "What is everybody's business is nobody's business," and inefficiency instead of bringing failure brings higher taxes.

The Training by Bureau of Public Roads.—The Bureau of Public Roads has lately inaugurated a procedure which we hope will better enable it to cope with the constantly increasing responsibility which we sense is coming upon us. A few years ago we started with four or five graduate civil engineers, who were just out of college, to collect cost data on highway construction work. It was an experiment undertaken for two purposes: The training of men and the reduction of cost through increased production. The success which attended this effort induced its continuation and extension. It was decided that we would endeavor to recruit our organization from men trained in this way, but to amplify the training to include studies which, if continued over a period of about three years, would qualify the men to undertake any reasonably responsible work included within the activities of the bureau.

For several reasons we decided to begin by taking men who had just finished the junior work in college and give them a three months' training during the summer vacation. We could in this way avoid competition in the selection of men. Practically no one has adopted this method, and I have been able to get the top man of the civil engineering class of each college I have visited. One man only is taken from each college. Furthermore, the average student even upon graduation is uncertain what branch of his profession he would prefer to follow. The three months' experience in close contact with highway construction enables the junior to get a fairly good idea of that sort of work, and if he does not like it he can avoid further study of highway engineering during his senior year. On the other hand, if he feels that he would like to continue in it, he can govern himself accordingly during that year. Again, these first appointments are temporary and enable us to study the man during the three months he is with us and decide whether it will be to our advantage to recommend his permanent appointment following graduation.

This year we took on 19 students who had just completed their junior year work, 18 in civil engineering and one in mechanical engineering. They are splendid young men who in each case stood at the very top of their class. During this vacation they all engaged in the study of highway construction methods and costs. They are all immensely interested in the work, and we hope to get practically all of them upon graduation. They are in each case working under the direction of an older and experienced man, so that they will not waste their time nor that of the government.

Believing that equipment efficiency is a vital element in cost, we are also planning to provide for the addition of a few mechanical engineers to our organization. We are proceeding in this case along the same lines as with the civil engineers and are seeking the same high grade of men. We find that equipment manufacturers are thankful to get reports concerning unequal or abnormal wear on machine parts and to receive descriptions of breakdowns.

How the Training Is Conducted.—We put these juniors at work with an experienced man for half of their vacation time on a study of construction methods and costs where grading is being done and half where paving is being done. They make stop-watch studies of every operation of the contractor. Average times previously obtained for a large number of jobs are made available to them, as well as times taken on many jobs excellently managed. With these standards it is a relatively simple matter, after a short study of the operations of an individual contractor, to ascertain just his position in a management scale running from bad to average and to excellent, and these stop-watch studies serve to indicate the reason for the rating. These studies are useful to contractors and they serve to bring the student into intimate contact with construction work and help him to decide whether he wishes to make highway engineering his life work. Usually they become intensely interested, and often the ideas of these bright young men are valuable.

With the experience gained during these months, the student returns to college and in due time is graduated. Some time prior to graduation we hope he will pass a United States civil service examination and be given a probationary appointment, which, if everything goes well, is followed at the end of six months by a permanent appointment.

Following the civil service appointment as a junior highway engineer, the appointee is again put at work on consecutive studies of construction methods and costs where grading is done with fresnos, with wheeled scrapers, with elevating graders and with power shovels. Excavation of all classes is studied. Studies are also made of surfacing and of paving of every type, and of bridge constructing, both steel and concrete. At appropriate times training is also given in our division of tests and in the other branches of the bureau's work. Incidentally, these young men, while studying construction costs and methods, learn to run the machines they study, and serve some time as foremen.

At the end of two or three years' training these men, as vacancies occur, are to be assigned to our district offices. It is not our intention, however, to cease our training activities upon such assignment. It is our purpose to attempt to secure an ever-increasing fitness so long as they remain with the bureau. Our conception of the bureau's position in the highway world requires that we go forward always, that we seek to point the way, and we can not do it unless our personnel is capable beyond all question.

We have lately laid the groundwork for a limited training of a few foreign students in highway engineering. Only those who come with proper credentials and evidence their intention to return promptly to their own countries for the practice of engineering will be assisted. It is believed that if this activity assumes reasonable proportons it will not only result in spreading the gospel of better practices in highway engineering but will be a considerable factor in continuing and strengthening the friendly relations between our country and others.

To the researches which we use as a vehicle for our training work we apply the criterion of usefulness. We are

looking for big dividends on the expenditures we are making. If we can increase production 10 per cent only, we shall be far more than amply repaid. We find that highway contractors are very much interested in the data we have been able to secure. In nearly every case studied, through the information we have furnished them as a result of our cost studies, contractors have been able to secure increased production, in some cases very greatly increased production, at little or no increase in cost. This fact induces me to suggest that men trained as I have described, when they are later detailed as inspecting or resident engineers, will be able to broaden their work to the end, and that, in addition to their other duties, they can secure and give to the contractor information which will enable increased production.

There is no work I can conceive of that rivals in interest and profit the development of men. This is particularly true of the engineer, because his activities are founded on facts, and facts are truth. To me the bureau's endeavor to raise the standard of its personnel to the highest plane is the most important of its undertakings, because with its accomplishment there will be established a mental equipment capable of any reasonable undertaking.

Some of the men we train we may lose. Some of them may decide to seek work in the state highway organizations; some may make connection with contracting organizations. If such should prove to be the case, we trust the training we have given them will enable them to render satisfactory service wherever they may go. We trust, furthermore, that any such transfers to the state departments will tend to cement the bond of fellowship we like to feel exists between the bureau and the state highway organizations.

Mexico to Send Delegation to A. R. B. A. Convention

Mexico has accepted the invitation of the American Road Builders' Association to take part in the program of the 1928 convention. It will send a delegation consisting of Señor Julio Garcia and Señor José Rivera, together with one or more members of the Comision Nacional de Caminos.

The delegation will take an active part in Pan-American Day, and Señor Garcia will present a paper on "Highway Construction in Mexico and Plans for the Future." This paper will be illustrated by stereopticon slides showing highways and highway construction in Mexico.

The Mexican Comision will send an exhibit which will be especially interesting and educational and an outstanding feature among the special exhibits that will be sent by the different states of this country and many Pan-American countries.

Road Tests of Automobile Headlighting

The U. S. Bureau of Standards has cooperated with the Society of Automotive Engineers and the Illuminating Engineering Society in research work on various phases of the automobile headlighting problem. Research associates assigned to the automotive power plants section have been engaged for several months in a systematic study of the types of light distribution required for satisfactory vision under usual driving conditions in the absence of opposing traffic. This work is done late at night on near-by highways, using cars provided with special test equipment which includes four head lamps mounted side by side on a bar so that they can be aimed individually or collectively. These lamps have interchangeable lenses of various kinds and the brightness of the lights is controlled by means of rheostats.

The usual method of test is to set up a dummy, about the size and shape of a grown man, and to record the various distances at which it can be seen and identified under various conditions with various lighting distributions. As might be expected, the darker the night the greater the visibility for a given beam intensity and pattern. Visibility is found to be practically the same for all speeds between a walk and 40 miles per hour. The effect on visibility distance of tilting the beam and of using lenses which give various vertical and horizontal spreads has been studied and the data are represented graphically by a series of three dimensional figures carved out of wood.

Attention is now being directed to a study of optimum illumination when meeting other vehicles. For use in this work, a test car belonging to the bureau has been equipped with one of the four head-lamp test sets and other special devices. The four head lamps are mounted at the rear of this car but are controlled from the driver's seat, as is a dummy which is carried on the right-hand running board. This car keeps some distance in advance of the observer's car until a suitable test location is reached. The driver then swings to the left, stops, and turns on his rear headlights, to simulate a car coming from the opposite direction. He also swings the dummy out alongside of his car. The observer keeps on until he can definitely distinguish the dummy beyond and to the right of the opposing lights. For convenience in measuring visibility distance, the observer uses an Army aiming circle as a range finder.

The National Automobile Chamber of Commerce has provided funds for this series of road tests which are under the general direction of a joint steering committee on headlight research. It should be pointed out that the present program contemplates no tests of commercial headlighting equipment. The aim is to ascertain what types of light distribution are preferable from the automobile driver's point of view. What devices will best serve to realize such optimum light distribution is a practical problem which must be left to the car and lamp manufacturers.

Regional Highway Planning Survey for Cleveland

Field work has been under way since Sept. 3 upon the Cleveland regional highway planning survey, embracing a territory within a radius of approximately 30 miles of Cleveland, Ohio. The survey is being carried on by the United States Bureau of Public Roads and Cuyahoga County as the principal co-operators. Information and assistance is also being rendered by the several administrative organizations responsible for highway development in the Cleveland region.

The preliminary work included a comprehensive study of traffic density —its distribution, origin, and destination—on the various routes in the area. This is being followed by a study of the traffic capacity of the various county highways and the principal entrances into the city of Cleveland and an analysis of the present highway system. Recommendations as to the location of new highway or relocation of present routes will involve consideration of the influence of such factors as topography, waterways, railroad terminals and yards, large industrial plants, suburban developments, and special use areas. With this information there is to be developed a plan of highway improvement adequate for anticipated traffic and designed especially to eliminate highway congestion. An improvement budget for a period sufficient to carry the complete plan into effect will also be prepared.

Traffic records were taken at 263 points in the area and show the daily and hourly volume of passenger cars, motor trucks, and motor busses on all important highways. Information was also taken as to weights of motor trucks. Records as to the origin and destination were taken for approximately 100,000 vehicles.

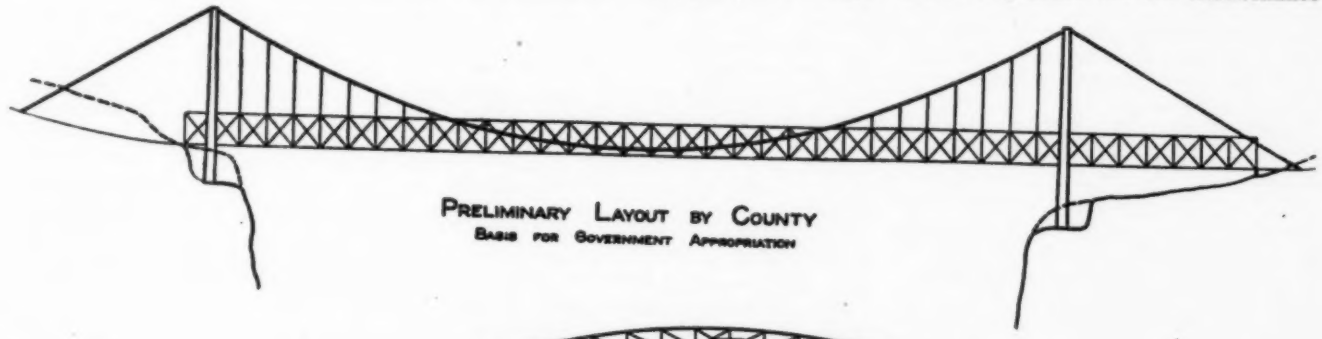
The "roughometer" was used in making a condition survey of the improved roads in the area. This instrument is attached to a passenger car and gives an accumulated record of the roughness of the surfaces over which the vehicle is driven.

Another new instrument, used for the first time in this survey, gives a record of the speed at which traffic moves at all points along a highway. This instrument is being used in studying traffic congestion and traffic capacity of various widths of highway.

Evolution of a Highway Bridge

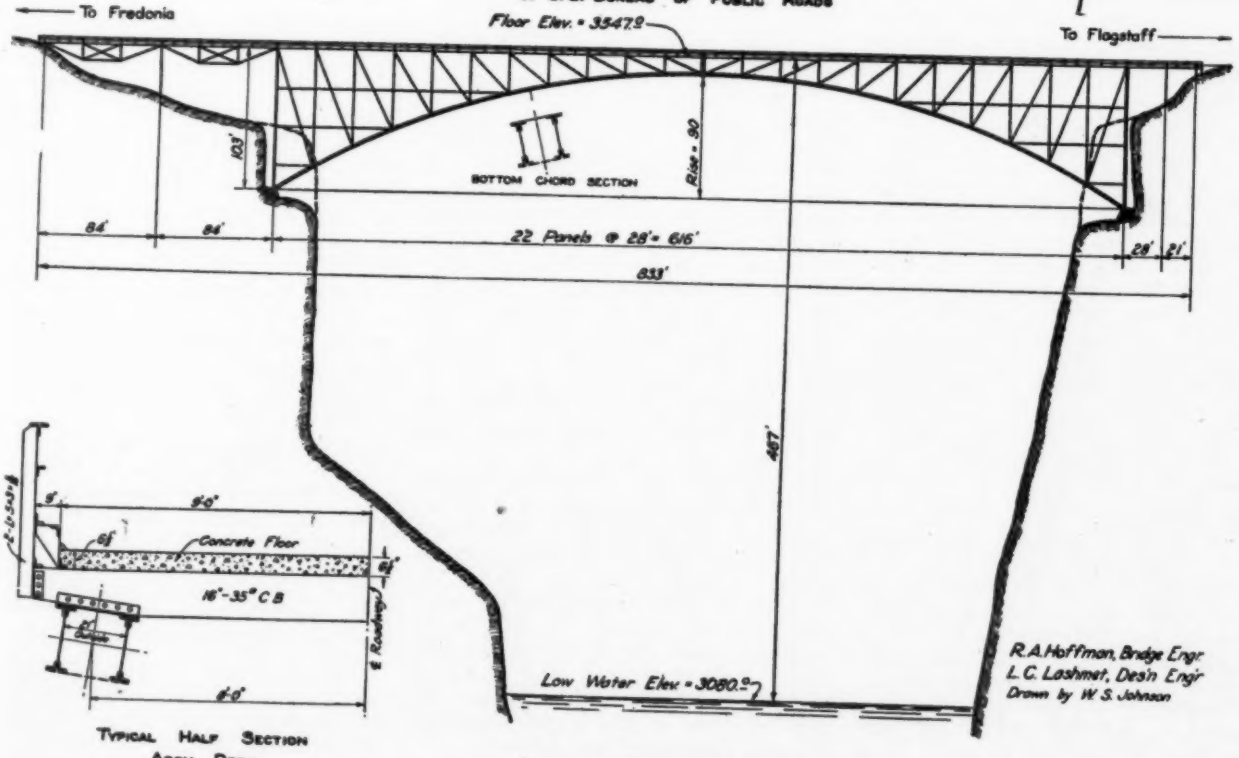
How Bridge Over Grand Canyon in Arizona Was Evolved from Preliminary Design to Obtain Economy of Construction—Features of Final Deck Arch Design

What is reputed to be the highest highway bridge on this earth is now about to be constructed in northern Arizona by the Arizona Highway Department to span the Grand Canyon of the Colorado River. This is to be a steel deck arch structure of 618 ft. span, and will be of the conventional three-hinged arch design. Cantilever erection is made possible by battered trusses designed for a reversal of stresses. The height of the roadway above low water will be approximately 467 ft. The total length of the bridge will be 833 ft., with two deck trusses 84 ft. long on the north end and two girder spans, 28 and 25 ft., on the south end. The bridge will carry an 18 ft. reinforced concrete roadway. This fireproof steel and concrete structure has been planned for low maintenance



PRELIMINARY LAYOUT BY COUNTY
BASIS FOR GOVERNMENT APPROPRIATION

PRELIMINARY LAYOUT
BY U.S. BUREAU OF PUBLIC ROADS



TYPICAL HALF SECTION
ARCH DECK

LAYOUT PROPOSED AND ADOPTED
BY THE ARIZONA HIGHWAY DEPARTMENT

First, Second and Final Designs for This Interesting Highway Bridge

costs and protection against the damage by fire experienced by wood bridge floors in this section.

The bridge site is 130 miles north of Flagstaff. That city is the nearest railroad point for the shipment of materials. While not on a present widely used highway, the route passing over the bridge will open up a territory noted for its scenic value, and will constitute a new route for north and south travel between points in Utah and Arizona. The present road, served by a ferry a few miles upstream, is a typical desert road and used but by those whose business takes them in that direction. The proposed improvement, however, should attract a large tourist traffic.

This site has always been considered as a logical place for a crossing of the canyon, and since the earliest settlements of the Mormons a ferry was operated at this point. In recent years the ferry has been owned and operated as a toll ferry by the county. At one time the D. & R. G. railroad had selected this site for a railway bridge on a location that was later abandoned.

In 1923 Congress passed a bill providing for an appropriation of $100,000 for a highway bridge at this point, provided that the state would appropriate a similar sum for the purpose. Then a survey by the United States Bureau of Public Roads disclosed that the total cost of such a bridge would be at least $230,000 for the lightest type of a highway structure and at least $341,000 for a steel structure with a 20 ft. concrete roadway. The next step was taken when the State Legislature appropriated $130,000 for the construction of the highway bridge at the last general session.

The State Highway Department then was called upon to study the matter, and as a result it was found necessary to design a different type of structure so as to conserve materials, since they would all have to be hauled 130 miles to the site. Estimated unit costs were also found to be too low in the initial estimate prepared for appropriation purposes. On the basis of this new design and estimate, the State then appropriated an additional $55,000 for the bridge, making total funds available $285,000. This was still too little for the type of bridge preferred by the Highway Department.

The first design, upon which initial appropriations were based, was a light ten ton suspension bridge, which was later found too light to carry the expected traffic. The second design prepared by the Government was for a half through arch, shown in the upper drawing. This would have necessitated the hauling of a great deal of excess material to the site, and would have thus been quite costly to erect. The material in the overhead system required for erection would have been useless in the finished structure, and not worth the cost of salvaging and shipping to another job.

A trial computation by the State Highway Department then showed that a deck arch would prove more economical since practically all erection material could be used in the approach spans, necessitated by grade line requirements.

A new design was therefore prepared in that office, providing for a temporary timber floor that could later be replaced by a concrete floor. After a bit of experimenting the final design as shown in the bottom drawing was evolved, designed for cantilever erection and so detailed as to make possible the use of almost all required tie-back material in the approach spans, with but little field revision of the members. This tie-back material included eye-bars designed for bottom chords of deck trusses, toggle-bars designed to make the truss posts, making expansion rockers of toggle-forgings, and so on. While the initial design of this final series was based upon a 600 ft. arch, a later survey discovered a fissure at one abutment that would endanger the stability of this bearing, and the design then had to be done over again based upon a span of 616 ft. in order to dodge this fissure.

According to the design finally adopted, the main span is a three-hinged arch of 22 panels, each 28 ft., with a rise of 90 ft., and a height from bottom pin to roadway of 103 ft.

The design provided for a dead load for roadway of 60 lb. per square feet, or 15,000 lb. per panel point of each truss, while the live loads allowed provide for one 15 ton truck or two A-12½ ton trucks side by side on the 18 ft. roadway.

In order that steel might be saved wherever possible, the design called for supporting the roadway on steel cross beams on 4 ft. 8 in. centers on top of the chord. This material is that formerly used as excess on the top chord during erection. The bottom chord is made up as a box member of eight angles and three plates, with the bottom laced with 6 in. channels. This chord is approximately 32 in. square, with a sectional area of 140 sq. in., and is 36 ft. long, weighing about 12 tons. The top chord is also built up of angles and plates laced top and bottom with batten plates.

Erection stresses, amounting to 750,000 lb. tension at each truss, are carried back to the erection anchorages by the top chords of the approach spans. These chords also carry the flooring on floor beams in the same way as on the main spans. After the erection stress is removed the top chord is easily able to carry the floor load in bending in addition to its taking its share of the direct stress as the top member of the truss.

The tension members and diagonals of the approach trusses are made from anchorage eye-bars made to fit the trusses. Packing rings were used in the eyes to take care of the smaller pins required in the truss. While the erection use of these members required that they be made greater in section than would otherwise be necessary, this extra material proved cheaper in the end than if special erection material would have been provided and then scrapped, due particularly to the long haul involved. The steel bids were consequently lowered.

The contract was finally let to the Kansas City Structural Steel Company at a bid of $310,000. With other costs added, including the cost of strengthening an old suspension bridge to care for construction traffic, the total estimated cost of the structure has been set at $341,000. The additional funds have now been raised to make possible the laying of the concrete floor at the time of construction. This was made possible by the Highway Department taking over the foundation work itself, and by funds secured from the county and from the nearby Indian agency.

Under the terms of the contract, the structure is to be completed by Sept. 1, 1928, and the approaches made ready for opening the bridge to traffic by Jan. 1, 1929.

Eight N. Y. Counties to Cut Grade Crossings

Hearings have been completed by Public Service Commisisoner William R. Pooley at Buffalo, N. Y., on proposed grade crossing eliminations in eight western New York counties, including Erie, Alleghany, Chautauqua, Cattaraugus, Genesee, Niagara, Orleans, and Wyoming. The hearings were conducted at Buffalo for three days. The purpose was to consider the elimination of crossings as proposed by the state superintendent of public works, the municipalities, grade crossing commissions, and railroads.

Proposed eliminations in the counties mentioned include: Two in Wyoming, two in Orleans, four in Niagara, three in Genesee, one on Cattaraugus, two in Chautauqua, four in Allegany, and nineteen in Erie.

After hearings on eliminations in all other parts of the state, now being conducted by other commissioners in other cities, have been completed, the Public Service Commission will fix a definite program for 1928. Thereafter, hearings will be conducted to determine the method of elimination and the method of financing the improvements.

The crossings will be eliminated in accord with the terms of the $300,000,000 bond issue act for that purpose, under which 50 per cent of the cost is paid by the railroad, 25 per cent by the state, and 25 per cent by the city, town or village.

Treatment of Earth Roads With Oil

Experiences in California and Nevada Together with Cost Data Given in September Public Roads

The earliest oil treatment in California consisted of the application of crude asphaltic oil, approximately a gallon per square yard, to the surface of a dirt road. The oil was allowed to penetrate at will or dirt was thrown on top. This was virtually a surface treatment and generally proved inadequate except for very light traffic or where the subgrade was unusually firm. The next development was the reworking of the thin mat, adding more oil and stirring to a greater depth. This was the crude beginning of the mixing treatment. The process was repeated in later years until some of the roads first treated had a surface 6 in. or more in thickness.

Paralleling the stage development, some of the counties have in the first operation deliberately built an oiled earth surface from 4 to 8 in. in thickness.

The success or failure of these oiled earth roads depends largely upon the character of the material. Sandy, gravelly, or even silty soils have produced serviceable roads in most instances where properly treated and maintained. Heavy clays or alkali soils have been similarly treated but the results have been almost universally unsatisfactory. These clays are inherently unstable, have high moisture-carrying capacity, and are constantly changing in volume. Uniformity of soil from point to point on the project is highly desirable, but experienced workmen will overcome considerable irregularity of soil by varying the quantity of oil and the details of treatment.

Cost of Treatment.—Under California conditions the cost of treating an earth road 18 ft. wide to a depth of 6 in. will approximate $3,000 or $3,500 per mile. The cost of a treatment 1 to 2 in. in depth, where conditions make such a light treatment satisfactory, is $200 to $500 per mile. Where the full depth of 6 in. or more is attained by progressive steps, the $3,000 cost will perhaps be reached in 8 or 10 years or more, this including the cost of maintenance during that period.

Heretofore the amount of oil for a given depth of treatment has been judged by the appearance of the product. The amount required depends, of course, upon the grading of material and probably follows the rules applicable to satisfactory sheet asphalt or asphaltic concrete, excepting that the lighter oil used in soil treatment covers the particles with a thinner film than the ordinary paving grades of asphalt. The amount of oil required is about one-fourth less than the amount of asphalt needed for the same grading. Samples show an oil content ranging from 4.5 to 10 per cent based upon the material passing a 10-mesh sieve.

This type of treatment is adapted to roads carrying less than 500 vehicles per day where soil conditons are suitable and particularly in arid or semiarid climates. The economy of omitting expensive road metal is obvious, and that possibility should always be considered. The oiled sand road in the Amargosa Desert in Nevada is typical. Here graveling was attempted and abandoned because of construction difficulties. The natural sand road was then oil treated and the surface obtained is as satisfactory as if the road had first been metaled.

Maintenance is a simple operation with blade and drag. Riding qualities are unexcelled and there is, of course, no dust. When reworking is required, a tractor, scarifier, and heavy blade grader must be available.

The examples and methods described hereafter are regarded as typical of oiled earth construction under somewhat varying conditions.

Oiled Sand Roads in Stanislaus County.—Oiled earth roads have been successfully constructed in Stanislaus County, Calif., for about 18 years. The soil in this area is fine sand and sandy silt. Without treatment the roads are extremely dusty and loose during the summer season.

The Turlock-Snelling road, extending east from Turlock for a distance of about 3 miles, is a typical example of this construction. The surfacing has a width of about 20 ft. and a depth of 6 to 7 in. The material is plastic under a hammer and more or less rubbery. The contour is smooth, and some gravel is visible which has probably been placed during maintenance. In a number of places fine surface cracks were noted during an inspection in July, 1926, but examination showed these to be only ⅛ to ¼ in. in depth through a thin hard crust which covered the softer plastic material beneath. The asphaltic oil in a sample cut from the road was alive and tacky. An analysis of this sample gave the following results:

	Per cent
Passing ½-in. screen	98.7
Passing 10-mesh sieve	98.5

The material passing the 10-mesh sieve was considerably finer than an ordinary sheet asphaltic mixture and the amount of silt slightly more than

Table I—Costs Per Mile of 14 ft. Oiled Earth Road in Riverside County, Calif.

Item	1924–1925 treatments			1925–1926 treatments					
	Ripley-Blythe Road	Avenue 62	Average	Morgan-Ickes Road	Avenue 58 and Monroe Street	Avenue 57 and Pierce Street	Jackson Street	Avenue 66	Average
Length, miles	8.13	2.00		1.51	2.00	1.00	2.00	4.00	
Oil, gallons per square yard	3.83	3.95	3.85	5.19	4.92	4.92	4.92	4.92	4.96
Average haul of oil, miles	2.4	7.0	3.3	8.0	7.0	2.25	4.5	10.0	7.36
Labor:									
Clearing and grading	$234.10	$285.05	$214.16	$671.44	$351.85	$415.59	$353.53	$421.43	$430.64
Watering subgrade	141.88	226.08	158.51	72.85	131.12		100.27	100.22	92.64
Hauling and spreading oil	359.17	501.30	387.22	602.81	573.38	368.60	434.55	421.50	473.85
Cultivating	122.69	132.06	124.54	82.99	82.13	92.50	142.41	73.15	91.29
Rolling	47.00	64.25	50.41	88.49	61.65	80.88	43.40	25.46	50.84
Dragging	36.82		29.55	2.65	44.15	7.86	2.58	14.28	25.35
Maintaining detour and miscellaneous	21.06	32.29	23.27	244.51	56.11	35.47	19.38	72.02	70.38
Supervision	55.72	94.45	63.31	242.82	79.86	69.55	48.19	45.50	83.19
Total (excluding grading and clearing)	784.33	1,050.43	836.87	1,337.12	1,028.40	654.76	790.78	752.03	886.80
Materials:									
Oil	1,190.18	1,255.31	1,203.04	1,526.99	1,443.93	1,443.93	1,443.93	1,443.95	1,455.87
Freight	996.24	523.43	902.89	714.02	675.18	675.18	675.18	706.44	692.66
Miscellaneous	15.78	13.44	15.32	49.67	27.23	65.00	27.50		23.74
Total	2,202.20	1,792.18	2,121.25	2,290.68	2,146.34	2,184.11	2,146.61	2,150.39	2,172.26
Grand total cost	3,220.63	3,127.66	3,202.28	4,299.24	3,526.59	3,234.46	3,290.92	3,328.85	3,489.70

the dust filler in such a sheet asphaltic mix. It had the following grading:

	Per cent
Passing 10-mesh sieve	100.0
Passing 20-mesh sieve	99.9
Passing 30-mesh sieve	97.4
Passing 40-mesh sieve	93.1
Passing 50-mesh sieve	84.1
Passing 100-mesh sieve	47.1
Passing 200-mesh sieve	23.8
Bituminous material	7.9

The following statement regarding the construction of this highway is abstracted from a report by A. J. Leedom, county superintendent, who has been in charge of construction. The natural soil was graded to a flat section about 26 ft. in width with very little crown, was loosened on top, and from 5 to 6 gal. of oil per square yard were spread in two equal applications. The first application covered a width of about 20 ft., and immediately the entire surface was plowed, starting at the edges and throwing furrows out, finally leaving a dead furrow in the center. This gave a roadway width of about 22 ft. The plowing was generally to a depth of about 6 in. The road was then harrowed, winding back and forth in order to break up the furrows and thoroughly mix the oil and earth. The second application of oil was spread, with more at the edges than in the center to prevent excessive concentration of oil at the center after the next operation. The entire surface was then replowed, throwing furrows to the center and bringing the road to a uniform section, harrowed as before, and finished with a steel drag, 7 or 8 ft. long and weighing about 600 lb.

The bituminous material was California asphaltic oil residuum containing about 65 per cent of 80-penetration asphalt, and was applied from a gravity spreader at a temperature somewhat less than 200° F.

The Turlock-Snelling road is about 3 miles in length and has been in service for 17 years. The traffic was undoubtedly light durnig the early years, but has now grown to approximately 500 vehicles per day, and the maintenance cost is reported to be less than $100 per mile per year. The original cost of the work by county labor was about $3,500 per mile.

Roughometer readings on the surface thus produced show a smoothness about equal to average asphaltic macadam. It is entirely dustless and to the casual observer might easly pass for a higher type of bituminous construction. The low construction cost and extremely low maintenance combine to give an annual service charge among the lowest for improved roadway investigated in this study. Several other sections of roadway in this locality constructed by the same methods and varying in age from 1 to 12 years, where sufficiently wide to keep traffic from breaking the edges, were found to be uniformly satisfactory. Some of the older roads, oiled to a width of 12 ft., had ragged edges and somewhat irregular surfaces.

Oiled Earth Roads in Riverside County.—Riverside County, Calif., constructed several experimental sections of oiled earth roads during the years 1924, 1925, and 1926, similar to the earlier work in Stanislaus County. Twelve and one-half miles was in the irrigated section of the Coachella Valley, where the soil is fine sandy silt, the climate extremely dry, and the roads almost impassable during the crop-hauling season.

The earlier projects were treated with 4 gal. of oil having a 60 per cent asphaltic content (80 penetration). The viscosity is not known, but the oil was fluid at temperatures of 100° to 150° F. The oil was spread in applications of 1 gal. per square yard, in widths of 6 and 8 ft., the finished width of roadway being 14 ft. Distribution was accomplished by a truck equipped with pressure sprays, towed through the loose soil by a 5-ton track-type tractor. Two sets of 4-gang disks followed the spreader and mixed the oil with the earth. This operation was repeated through four applications of 1 gal. each and the oil was mixed with the earth to a depth of about 5 in. In the later projects the oil was increased to 5 gal. and cultivated to a

Table II—Distribution of Oil on Nevada Federal Aid Project No. 46—An Oiled Earth Road

Station to station	Length	Area of surface[1]	Quantity of oil applied		Number of applications		Total quantity applied		Kind of material in roadbed
			Total	Per square yard	61-64.5 per cent asphalt	85 per cent asphalt	61-64.5 per cent asphalt	85 per cent asphalt	
	Feet	*Sq. yds.*	*Gals.*	*Gals.*			*Gals. per sq. yd.*	*Gals. per sq. yd.*	
765+00- 794+50	2,950	3,278	15,805	4.82	4	1	4.15	0.67	Sand.
794+50- 812+00	1,750	1,944	11,098	5.71	4	2	4.41	1.30	Do.
860+00- 873+00	1,800	2,000	9,603	4.80	4	1	4.12	.68	Do.
878+00- 916+00	3,800	4,222	18,291	4.33	4		4.33		Do
916+00- 930+00	1,400	1,556	7,223	4.64	4	1	4.11	.53	Do.
930+00- 935+35	535	594	3,411	5.74	5		5.74		Do.
935+35- 941+45	610	678	3,000	4.42	4		4.42		Do.
941+45- 973+00	3,155	3,506	11,800	3.37	3		3.37		Do.
973+00-1022+10	4,910	5,455	22,412	4.11	3	1	3.50	.61	Do.
1022+10-1040+00	1,790	1,989	9,830	4.94	4	1	4.25	.69	Do.
1040+00-1050+00	1,000	1,111	4,396	3.96	3	1	3.27	.69	Do.
1050+00-1081+90	3,190	3,544	15,540	4.38	3	1	3.65	.73	Gravel.
1081+90-1085+88	398	442	1,536	3.47	2	1	2.59	.88	Do.
1085+88-1087+80	192	213	479	2.25	1	1	1.47	.78	Do.
1087+80-1122+00	3,420	3,800	15,589	4.10	3	1	3.31	.79	Do.
1122+00-1123+00	100	111	85	.77		1		.77	Do.
1123+00-1127+00	400	444	1,741	3.92	3	1	3.15	.77	Do.
1127+00-1210+00	8,300	9,222	13,701	1.48	1	1	.64	.84	Do.
1210+00-1227+00	1,700	1,889	2,807	1.49	1	1	.48	1.01	Sand.
1227+00-1235+35	835	928	1,863	2.01	2	1	1.18	.83	Do.
1235+35-1240+00	465	516	865	1.68	1	1	.87	.81	Do.
1240+00-1284+20	4,420	4,911	29,593	6.02	5	1	5.41	.61	Do.
1284+20-1297+46	1,326	1,473	6,589	4.47	4	1	4.01	.46	Do.
1297+46-1312+00	1,454	1,616	9,454	5.85	5	1	5.39	.46	Do.
1312+00-1343+24	3,124	3,417	16,914	4.96	5		4.96		Do.
Total	53,024	58,913	233,625						
Average				3.97			3.39	.58	

[1] Surface assumed to be 10 feet wide. Actual width greater, due to turnouts and spreading of soft material under traffic.

Table III—Summary of Cost of Nevada Federal Aid Project No. 46—An Oiled Earth Road

Item	Cost per mile		
	Labor	Equipment and supplies	Total
Preparing subgrade	$25.19	$65.00	$90.19
Trenching for surface	93.85	162.00	255.85
Applying oil	829.92	1,406.00	2,235.92
Oil		1,788.39	1,788.39
Applying sand and cultivating	257.16	180.70	437.86
Dragging and final shaping	90.21	86.70	176.91
Signs		10.46	10.46
Total	1,296.33	3,699.25	4,995.58
Cost per square yard (6,100 square yards per mile)			.82

Table IV—Analysis of Samples From Nevada Federal Aid Project No. 46—An Oiled Earth Road

[Samples taken in June, 1926, two years after construction]

Station	Dimensions of section		Quantity of oil applied (gallons per square yard)	Fraction of aggregate passing various sieves (per cent)									Oil content (per cent)
	Width	Depth		10-mesh	14-mesh	20-mesh	30-mesh	40-mesh	50-mesh	80-mesh	100-mesh	200-mesh	
	Ft.	*Ins.*											
770	12.0	5.75	4.82	95.8	95.3	94.8	90.9	82.5	69.7	45.7	27.3	8.9	8.47
900	13.0	5.05	5.71	98.3	97.9	97.5	94.4	84.3	67.9	43.7	25.4	7.8	7.27
900	11.5	7.05	4.33	90.9	89.7	88.8	85.1	75.8	63.9	43.6	26.9	8.5	6.40
950	11.0	3.65	3.39	92.5	90.7	88.8	84.5	75.2	62.2	44.6	29.8	11.2	8.20
1045	12.5	4.60	3.40	93.0	91.5	89.9	84.8	76.3	66.7	49.6	34.9	15.5	7.32
1250	12.0	6.45	6.02	87.3	86.2	85.1	83.4	75.4	63.8	42.2	25.0	6.7	6.73
Mean	12.0	5.42	4.61	91.3				78.2		44.9	28.2	9.8	[1]7.40

[1] Equals 8.1 per cent of aggregate passing 10-mesh sieve.

depth of 6 in. After cultivation, the surface was smoothed with a grader and rolled with a 10-ton power roller. In some instances the roads were opened to traffic before rolling. William S. Conner, the engineer in charge of this work, expresses the opinion that extensive rolling is unnecessary and that consolidation can best be obtained by permitting traffic to use the road, provided it is kept smooth by drags.

The surface resulting from this treatment was practically identical with that in Stanislaus County where soil conditions were similar. On the Ripley-Blythe Road, where the soil contained a considerable percentage of clay, 4 gal. of oil did not produce uniformly satisfactory results, and the surface remained more or less unstable.

The Riverside County work is too recent to be interesting from a service standpoint, but is valuable because of the excellent cost data furnished by Mr. Conner. Table I shows the average cost to be practically $3,000 per mile, exclusive of clearing and grading.

During an inspection in February, 1927, it was found that several sections had been resurfaced with about 1 in. of crushed stone, treated with 90 to 95 per cent road oil, and covered with chips. Sections not metaled are carrying traffic satisfactorily although they do not have the appearance of being maintained.

Oiled Sand Roads in San Bernardino County.—J. S. Bright, construction engineer, Bureau of Public Roads, gives data regarding the oiling of desert roads under his direction as county highway engineer of San Bernardino County in 1916. The natural road material in this case was sand. Intermittent sections of the Barstow-Needles road, aggregating about 40 miles, were treated to a width of 8 ft. with 2½ gal. per square yard of oil having an asphalt content of 60 per cent. The road received very little attention until taken over by the state highway commission in 1924. Traffic, which at first amounted to 100 or more vehicles daily, has since increased to about 400 and the surface has been practically destroyed in many places.

One section, extending from Amboy easterly for about 15 miles, reecived 4 to 4½ gal. of oil per square yard on a width of 10 ft. The resulting surface was 5 to 6 in. in depth and is still in fair condition, although it received practically no maintenance for the first eight years. The natural material is a gravelly sand considerably coarser than that treated in Riverside and Stanislaus Counties. Samples were removed for test in February, 1927, and the oil was found to be alive and sticky. It was found that 30.9 per cent of the total was retained on the 10-mesh sieve and consisted of coarse sand, mostly less than ¼ in. in diameter. The portion passing the 10-mesh sieve was graded as follows:

	Per cent
Passing 10-mesh sieve	100.0
Passing 20-mesh sieve	71.6
Passing 30-mesh sieve	42.5
Passing 40-mesh sieve	37.0
Passing 50-mesh sieve	31.6
Passing 100-mesh sieve	22.4
Passing 200-mesh sieve	11.0
Bituminous material	8.1

The condition of the Amboy section after 11 years of rather heavy service almost without attention indicates that similar construction of adequate width, properly maintained, would carry traffic very satisfactorily over the desert sections. The cost of such treatment would probably be about the same as reported in Riverside County.

Oiled-Sand Surface on Nevada State Highway.—A 10-mile section of the Las Vegas-Beatty road in the Amargosa Desert in Nevada is a recent example of oiled-sand construction. This section of highway, designated as Nevada Federal Aid Project 46, belongs to the same general type as the Amboy section in San Bernardino County, Calif. The difficulties encountered were extreme and unusual. The shifting sand was almost impassable for motor traffic prior to the improvement, and during construction the trucks could not travel through the sand without the assistance of tractors.

Late in 1922 bids were requested for the construction of gravel surfacing. Only one was received and that, being 84 per cent higher than the engineers' estimate, was rejected. In January, 1923, the State highway department undertook the work by day labor and opened a gravel pit near the middle of the 10-mile project. Because of the isolation of the job, the extremely hot weather, and transportation difficulties the work was discontinued after five months with but 2 miles partially constructed. The cost of gravel being prohibitive, early in 1924 the department undertook to mix asphaltic oil with the natural soil to a depth of approximately 6 in. The oil used for mixing purposes had an asphalt content of 61 to 64.5 per cent of 80-penetration. The roadway was to be trenched to a depth of approximately 6 in., and the material removed from the trench was piled along the shoulders to be used for covering the oil. Shortly after beginning work the depth of trenching was modified to approximately 3 in., as the casting of sand upon the oil was found unnecessary and uneconomical except in small quantities.

After the first application of oil upon the prepared subgrade the roadway was cultivated with a double-action disk harrow. A second application of oil followed and was partially covered with sand from the shoulders to prevent the oil from collecting in large pools. Disking was resumed, followed by a large road grader which moved the oiled material into a windrow first on one side of the road and then on the other, and finally leveled it for the third application. The grader was the most effective implement used for mixing. This procedure was repeated until the required amount of oil had been applied and mixed. On most of the project four applications were spread. Table II shows data regarding amounts of oil used and number of treatments.

When the surface became uniform in appearance, it was shaped with the grader to a crown approximating 2 in. and compacted with a sheeps-foot roller. For the final smoothing, a drag 10 ft. wide by 20 ft. long was used in conjunction with an ordinary roller 3 ft. in diameter having a weight of approximately 175 lb. per inch of width.

After the mixing was completed and the surface compacted, part of the project was covered with road oil containing 85 per cent of asphalt (80 penetration). This treatment, as shown in Table II, was varied according to the condition of the surface, one section receiving the maximum of 1.30 gal. per square yard.

The plans called for a roadway 10 ft. in width with 18 turnouts. Actually the width averages 12 ft. because of a general squeezing outward during construction and under traffic before the mixture hardened.

The cost, shown in Table III, averaged practically $5,000 per mile, or $0.82 per square yard. This is above normal because of the remoteness of the work. Oil was shipped from Los Angeles in tank cars, and was hauled an average of 19 miles from the railroad in distributor trucks having a capacity of 600 to 800 gal. The work was carried on during extremely hot weather, so hot, in fact, that the light oil required no artificial heating.

The 2-mile section which had previously been graveled received the same treatment as the desert sand, except that the amount of oil was cut approximately in half and the thickness of the oil mixture proportionately reduced.

Two years after completion the surface was examined for width and thickness, and six samples were analyzed. The results are shown in Table IV. The oil content ranged from 6.40 to 8.47 per cent, averaging 7.40 per cent. The sand grading resembles that of sheet asphalt.

The roadway produced meets traffic requirements. It is smooth, and with moderate maintenance will probably be durable. It is not as dustless as anticipated, because a film of sand has been kept on the surface to absorb surplus oil. Evidently the heavy oil last applied has furnished unnecessary richness at the surface. Evidence is lacking that it added to the quality of the work.

Emergency Oiled Sand Road in Imperial County.—In December, 1926, a heavy flood destroyed nearly 2 miles of concrete pavement on the San Diego-El Centro road about 30 miles west of El Centro, Calif. The damaged road was paralleled by a broad expanse of sand in the Myers Canyon Wash, a

strip of which was promptly oiled to serve as a detour pending reconstruction. Nominally 5 gal. per square yard of 60 to 70 per cent "fuel oil" was spread, but tests indicate that the actual rate of application was somewhat less than 4 gal. per square yard; the excess having been used to attain extra width. The oil was mixed with the sand by cultivation and grading to a depth of about 7½ in. By the end of January, 1927, the surface had attained a fair degree of consolidation. On Feb. 22 the center was supporting heavily loaded trucks and ordinary automobiles were running over the detour at 40 miles an hour. The edges, subjected to comparatively little traffic, were still soft.

A sample was taken on Feb. 13 for test. All material passed the ¾-in. screen, 97.9 per cent passed the No. 3 screen, and 79.7 per cent passed the No. 10 sieve. The 10-mesh material had the following grading:

	Per cent
Passing 10-mesh sieve	100.0
Passing 20-mesh sieve	61.0
Passing 30-mesh sieve	36.5
Passing 40-mesh sieve	26.6
Passing 50-mesh sieve	18.2
Passing 100-mesh sieve	8 6
Passing 200-mesh sieve	4.9

The oil content was 3.6 per cent of the total, or 4.5 per cent of the 10-mesh material.

The sand in this temporary road is coarser than any other treated soil described. The amount of silt and clay is negligible. The oil content is low, but the appearance of the road shows that ample was used.

To Spend $30,000,000 on Grade Crossings

Eighteen grade crossings will be eliminated on Atlantic avenue, from East New York to Jamaica, a prominent highway leading out of New York City, by placing the tracks of the Long Island Railroad in a subway between those points, under engineering plans approved by the board of estimate and recommended to the transit commission. The transit commission already has informally approved this solution.

The cost of the project will be about $30,000,000, most of which will be borne by the City of New York, since it entails improvements not specifically involved in the elimination of the crossings. While it is expected the Long Island Railroad will continue to urge elevation of the tracks as the cheaper method of elimination, this recent action is thought to be the end of the long controversy over Atlantic avenue.

If the plan approved is finally ordered by the transit commission it means that Atlantic avenue will be transformed into a wide boulevard and the Long Island trains on that branch will run underground.

Highway Safety Campaign of American Road Builders' Association

The results obtained from the Highway Safety Campaign have exceeded those of the most optimistic. On Oct. 1, newspapers and magazines all over the country commenced carrying copy prepared by the Road Builders' Association. Civic clubs, to whom the safety prospectus had been sent, immediately started to have highway safety programs. Safety councils in the various cities conducted a campaign utilizing further major activities, information and plans furnished by the Road Builders' Association. Schools took advantage of the campaign and added to their present plans of teaching safety to the children. Highway commissions, as well as the industries, responded to the call for greater highway safety and took an active part in the campaign.

One of the features of the campaign was the signing of the highway safety pledge card. Nearly one hundred thousand of these cards have gone forward and additional requests are being received daily. The far-reaching effects of the campaign can best be judged by the letters received from little children, mothers, fathers, newspaper editors and men who have made highway safety a major study. The great cooperation extended by other associations conducting campaigns of highway safety added greatly to the results obtained. Twenty-five thousand of the prospectus on highway safety were sent to the churches, and the replies received from the many hundreds of ministers show that the ministry is anxious to take a very active part in this practical problem of bringing about greater highway safety.

The safety councils of several cities have taken a very active part, and one city is to make a request for 46,000 pledge cards. The eagerness with which the pledge cards are sought, and the value in which they are held, shows that this tangible effort of an attempt to maintain highway safety is one well worth while.

The Road Builders' Association has now covered the United States and brought the subject of highway safety before many people who heretofore had considered it lightly. From now on a more intensive campaign in selected parts of the country will be undertaken and it is hoped that, through the efforts of the Road Builders' Association and other associations and organizations taking part in the highway safety campaign, this great subject will be brought to the attention of every individual and, through the combined effort of all, highway safety will be brought about both for the motorist and pedestrian.

Expenditures for Road Work in Washington

Since February. 1927, approximately $7,500,000 has been obligated for new construction, rights-of-way and engineering on state highways in the state of Washington, leaving approximately $9,300,000 to be allotted, according to a recent statement by State Highway Engineer Samuel J. Humes. The expenditure embraces 95 contracts.

A portion of the $200,000 appropriated by the 1927 legislature for study of the problem of dust prevention has been applied for the use of oil and calcium chloride, "with varying degrees of success," Humes said. "Light oil spraying and the usual amount of blade work is all that we can afford," the engineer said experience showed, and the plans for the coming season will be limited to such methods.

Humes added that the $9,000,000 available for the rest of the biennium "will be allotted as fast as seasonal or other controlling conditions permit. In any event we expect to have the whole program on its way early in the coming year."

Shortening of the distance between Vancouver and Blaine by 22 miles, construction of an entirely new road between Cle Elum and Ellensburg, betterment of approaches to Mt. Rainier National park and opening of the route between Longview and Cathlamet on the Ocean Beach highway are some of the major projects planned, Humes said.

Weather and Road Construction

Too much emphasis cannot be laid upon the weather reports and weather indications. In a recent study made by the United States Bureau of Roads, weather conditions are credited with being responsible for one-half of all time lost on concrete road construction. The damage done by frost is comparatively negligible. Moisture absorption is affected by low temperatures. The losses that count are caused by continuous rains. The results of the study mentioned are the authority for that statement.

It pays to be weatherwise. Weather reports will help.—Public Construction News.

Newspaper Boxes Taken from Missouri Roads

The Missouri State Highway Commission recently, by resolution, instructed its engineers to remove from the rights of way newspaper receptacles, considered by the commission to be a form of advertising. The resolution became necessary through the refusal of one Kansas City publication to remove their boxes. Those St. Louis newspapers which used this form of advertising on the highways readily complied with the request.

Bridge Approach Paving

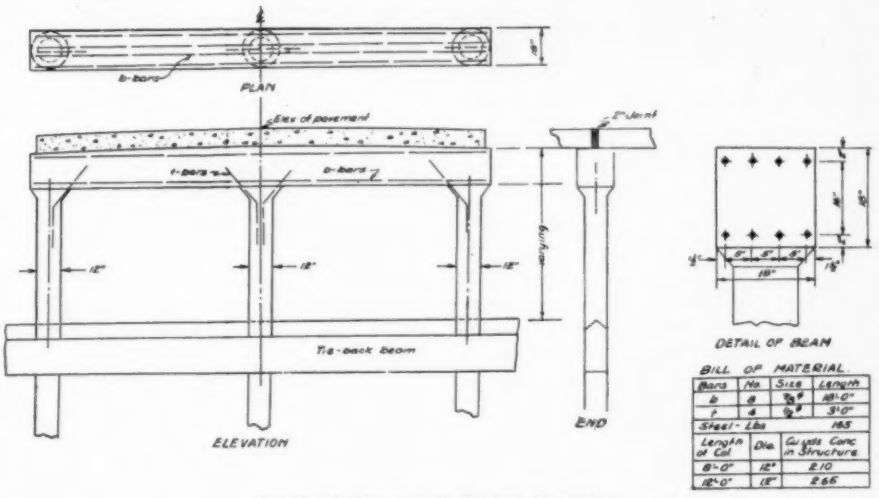
A Method of Preventing Settlement of Slab Laid in Fill

By HARRY F. BOSSART
District Engineer's Office, Illinois Division of Highways, Paris, Ill.

Because of the fact that the construction of certain bridge projects and the construction of the pavement in the same section are carried on simultaneously, and that there is usually a large fill adjacent to the abutments of the bridge which cannot be made until the abutments are completed, it has been necessary to delay laying the slab for a small distance on each side of the bridge. These bridge gaps, from 50 to 150 ft. in length, soon become rough after the road is opened to traffic, and are a continual source of annoyance to the traveling public and the maintenance department. The Illinois Division of Highways has tried to expedite the paving of these gaps, but has had considerable trouble due to the settlement of the fill. Pavement laid, even after the fill has been made two years, has settled very badly, causing a bumpy and wavy pavement, which has not been much better than the stretch was before it was paved.

A standard bridge approach slab has been designed, but is applicable only where the fill is less than 12 ft. (18 ft is the longest reinforced span that can be practicably used in this case. The length of span of standard approach slabs is determined by the height of fill—length of span equals 1½ times height of fill.)

A solution of the problem—the laying of slab adjacent to bridge soon after the completion of the bridge, with elimination of future settlement of the slab, seems to be found for one case, or type of bridge, and has already been put into use in this district on the Edgewater Park Bridge east of Charleston, Ill.


PLAN
Elev. of pavement
Tie-back Beam
ELEVATION
END
DETAIL OF BEAM
BILL OF MATERIAL
Bars | No. | Size | Length
b | 8 | ⅞" | 48'-0"
f | 4 | ⅞" | 3'-0"
Steel - Lbs | | | 185
Length of Col. | Dia. | Cu yds Conc in Structure
8'-0" | 12" | 2.10
12'-0" | 15" | 2.66

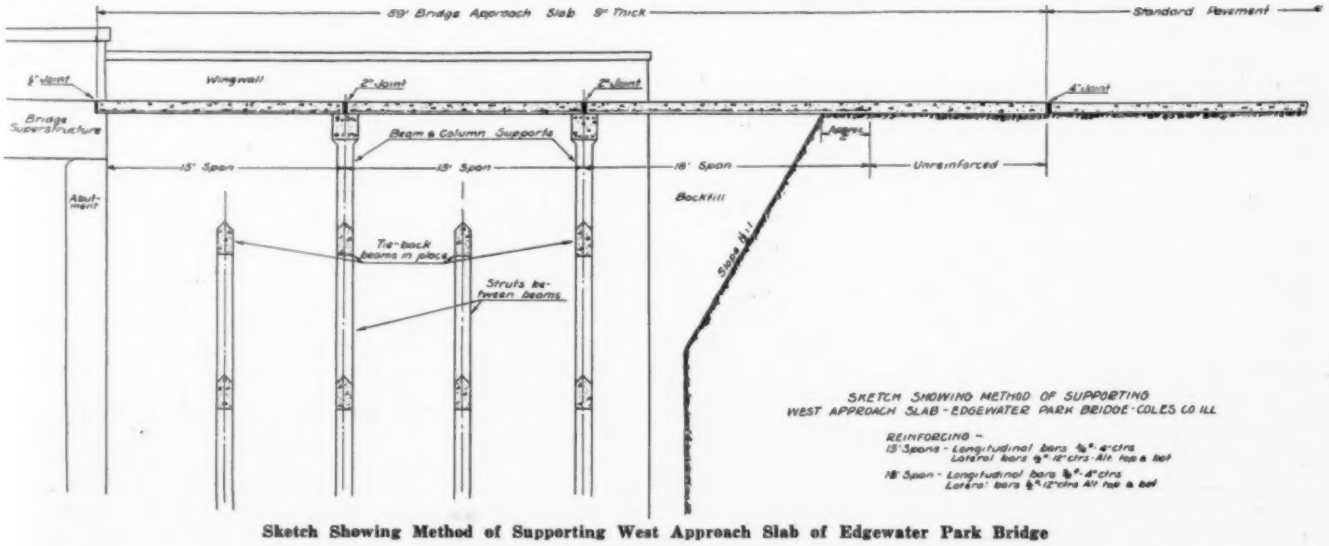
Details of Beams and Column Supports

The type mentioned is where the wingwalls of the bridge are held together or "tied-backed" with a series of concrete beams. This is usually the case where the fill is high and the wingwalls long. In the case of the Edgewater Park Bridge, in the west wingwalls, there were four sets of tie-back beams, 7½ ft. apart horizontally, the first set being 7½ from the inner face of the abutment. The beams were 5½ ft. apart vertically, the top beam being 5½ ft. below the crown of the proposed pavement. Between the beams vertically, were concrete struts or columns, (12 in. round) one of these being placed under the center of the roadway and one 9 ft. each side of the center, making them directly under the edge of the pavement for an 18 ft. slab. Under the lowest tie-back beam the columns extended down to the footing, which made a very substantial supporting structure for the purpose we had in mind.

On the 2nd and 4th top tie-back beam, we placed 12 in. round columns directly over the columns between the beams, which, as stated, were under the center and each edge of the proposed pavement. On top of these columns, parallel to the tie-back beams and at right angles to the center line of the road, was placed the supporting beam (18 in. sq., reinforced with eight ⅞ in. round rods). Thus we had a supporting structure for two 15 ft. slab spans, which, with a standard 18 ft. bridge approach slab, made 48 ft. of reinforced slab out of a total gap of 59 ft., making settlement impossible on the 30 ft. next to the bridge, and greatly reducing the danger of settlement on the remaining 29 ft.

On the east gap the same plan was carried out. Here, however, the gap was only 55 ft., and a different arrangement of the tie-back beams required one span of 13 ft., one of 14 ft., and with the standard 18 ft. span, giving 45 ft. of reinforced slab out of 55 ft.

One-way traffic was maintained while the supporting structure was being built and the pavement laid, except for about 10 minutes when a beam was being poured, to allow it to be tamped and the top to be finished off. Test beams were taken as the pavement sections were poured, sufficient strength usually being obtained in four days to allow the section to be opened to traffic.



Sketch Showing Method of Supporting West Approach Slab of Edgewater Park Bridge

Safety Measures on State Highways

Responsibility of State Highway Department in Protection of Life and Property Discussed in Paper Presented Oct. 5 at 13th Annual Meeting of American Association of State Highway Officials

By G. C. DILLMAN

Deputy Commissioner-Chief Engineer, Michigan State Highway Department

The American Association of State Highway Officials held its first meeting at Oakland, Calif., in September, 1915. That year the total registration of passenger cars in this country was 2,309,666 and of motor trucks, 136,000—a total of 2,445,666. The registration of passenger cars for 1926 had increased to 19,287,171 and motor trucks to 2,764,222—a total registration of 22,001,393—almost eleven times the registration of 1915.

We must not forget that this great increase in numbers of units was accompanied by a corresponding increase in speed, the uses to which these vehicles have been put covers all fields of service and the average motorist now thinks nothing of driving from 200 to 300 or more miles per day, yet ten years ago the same driver hesitated in driving half that distance even on reasonably good roads. It is no wonder that our problem as road builders is complicated.

More Than $1,000,000,000 Spent Yearly on Roads.—More than one billin dollars is being expended annually on our public highways. It is not sufficient that this money be expended economically, but our highways must meet the requirements of service, of safety and be attractive in appearance. The subject assigned me has to do with the responsibility of the State Highway Department in the protection of life and property. At the rate people are being killed and injured in traffic accidents in the United States, two persons will be killed and at last forty injured during the few minutes I am addressing you. Surely that is appalling and remedies must be found.

It seems that the pages of newspapers and magazines are filled with reports of what individuals, committees, associations and public bodies are doing and planning to do in promoting greater safety on our public thoroughfares. To be sure something is being accomplished, publicity of this kind is good and the public interest is being aroused to the situation. But the knock-out blows have not yet been struck. It seems to me that we, in America, with all our advantages and easy means of living, have allowed ourselves to slip into a groove that leads to but one line of thought concerning these accidents. Regardless of how serious the accident or how it might have been prevented, the mass reaction is to excuse and to forget. As a result we have become mentally hardened to the situation and instead of having highways and streets for the legitimate and safe use of business and pleasure, they are literally strewn with the wreckage of human life and property.

Practically all states have laid out a rather complete highway system, but regardless of the extent of improvement, the system is subject to continual change in some manner. These changes and additions should be made only after a study of present and future needs. A number of highway transport surveys have been completed and should be of great value in economic and engineering research. The system should provide for enough roads but avoid duplication in some localities and a lack of necessary roads in other localities as obtains at present.

Free Flow of Traffic Necessary.—Traffic conditions vary materially over different sections of a state, being heaviest in and adjacent to centers of greatest population. Much study should be given the problem of getting traffic through the cities and villages. The safety, economy and efficiency of highway transportation requires the elimination of all obstructions to the free flow of traffic. Anything tending to impede the continuous and uniform movement adds an element of danger in addition to increasing the cost of transportation. The most direct practicable route should be provided adjacent to cities when the daily volume of traffic is large. Local and suburban traffic added to the interurban traffic calls for the opening up of parallel streets and the construction of "by-pass" routes.

The design of the highway as a whole is dependent on the width of the right-of-way and too often the design of the highway has not kept pace with the design of the road surface. Our attention has been so focused on the problems incident to improving the road surface for durability and economy that we have often neglected to design the highway as a complete whole, to properly meet its many requirements. Maximum service is paramount for the present and should provide the public with highway structures adequate and safe or the future.

Widths of Roadway and Pavement.—Now then, what is the width of right-of-way required for the highway of today and tomorrow? This subject has been given much study in Michigan along with a number of other states and I believe highway officials, engineers and other authorities are in quite common agreement on a minimum of 100 ft. This width should provide for an ultimate 40 ft. pavement to take care of four lanes of traffic, shoulders of proper width, space for side drainage ditches, trees, pole lines and footpaths. The so-called superhighway adjacent to and connecting the larger industrial centers should have a right-of-way width of from 150 to 200 ft.

This question of the width of right-of-way is receiving considerable attention and it will continue to receive more and more attention until it is properly met. Is it reasonable to sacrifice highway service, to jeopardize the lives of people traveling over the highways, to sacrifice the appearance of the highway and continue to spend money on roads of inadequate width just because it would take a little more money and some effort to acquire ample widths? I am fully convinced that the time has come when state highway officials should provide ample right-of-way widths on their trunk line roads before proceeding with new construction or reconstruction. I am also convinced that the highway authorities should be as jealous of the right-of-way as are the railroads and should keep them free from encroachments. The highways concern the safety and welfare of all the people, a greater consideration than the convenience of any individual, and surely the authorities who represent the public in the development of this great program of highway improvement should protect and preserve the rights of the public in such highways.

Design of Road Grade.—It is often been said that the road grade is the only permanent part of a highway. If that is true, then should the engineer not lay greater stress on its design? Road shoulders serve a much more important part than to merely help hold the gravel or back up the edges of a pavement. Still we find highways being built today having shoulders not over 3 or 4 ft. wide.

Our rural highways should be graded of such width that parking may be confined to the shoulders and this should be mandatory on all main roads. This is especially important where two way traffic is provided. The width outside of the surfaced paved portion of the highway should be not less than 8 ft. and sufficiently strong to carry turn-out traffic and to handle parked vehicles. Narrow road shoulders continue to exact a heavy toll in life and property. It is easy to ditch a car

in avoiding oncoming and in passing vehicles and the danger from the parked vehicle is even greater.

Road grade slopes should be flat, say 4 to 1, to allow for reasonable safety in driving off the grade and in case deep open ditches are necessary, they should be constructed 40 or 50 ft. from the center line.

Main Highway Surfacing.—The surfacing on our main highways should be a minimum of 18 ft. wide since the maximum width of truck bodies generally allowed is 8 ft. and there must be some clearance for two lines of fast moving traffic. I believe the time has come when pavements on our main highways should have a minimum and standard width of 20 ft. and any increases in this width should be at 10 ft. intervals. Then too, these 10 ft. intervals or units should be well defined with line markings. The next width would be three lanes of traffic, but it is quite generally agreed that this width can be justified only from an economic standpoint. The maximum safety in design for a highway carrying traffic in two directions lies in either the two lane or the four lane roadway.

One of the most important accessories on our highways is the guard fence. A guard rail of substantial type should be built along all roads having steep embankments. Wooden rails should be discontinued on account of the possibility of pieces of the rail piercing a motor vehicle when the fence is hit. This type of fence has been the direct cause of many fatal accidents and such construction is "passe."

Whether the highway is through rolling country or over level terrain, good sight distance must be provided. There should be a minimum of 500 ft. for both horizontal and vertical curves. Obstructions to good vision, especially at road and street intersections and at railroad grade crossings, should be avoided in new construction and steps taken to do away with this condition on all traveled roads. Maintenance forces should be on the lookout for trees and roadside growth that interferes with good sight distance.

Produce stands, loading platforms and gas and oil filling stations should not be tolerated at the edge of the road grade. They are an ever present source of danger and traffic congestion that must be solved. Business of this kind should be barred from operating within the highway right-of-way, at least their patrons should not be permitted to park their cars within the limits of the road grade.

Footpaths and Sidewalks.—A study of traffic accident statistics reveals the fact that the pedestrian is having his share of trouble. Thus far he has been allowed to follow his own inclination and any regulations brought about have usually been directed against the driver of the motor vehicle. There is a crying need for footpaths alongside these roads carrying a large volume of fast long-distance traffic through well populated and growing districts.

It will not be necessary for a state to spend large sums of money for these footpaths or sidewalks, because they should follow the natural contour of the country—adequate drainage being provided—construction may be of the least expensive materials which may be available and not necessarily of any one type. These footpaths should not be located on the road grade unless separated from vehicular traffic by a guard fence. A location entirely off the grade and back of ditch lines affords the maximum safety as well as more economical construction. All bridges should be provided with sidewalks or safety zones thus safeguarding pedestrians and wheel traffic.

Getting school children, especially in the rural districts, along and across the main highways is a serious problem. Road officials should exert themselves in this direction, building footpaths, providing and designing better crossings for the children and on heavy traffic highways, consider the practicability of pedestrian subways.

Elimination of Highway Hazards.—The first and best chance to eliminate hazards from a highway is during its first construction. The growth and changed conditions in traffic, necessitating many changes in designs has thrown the burden onto the maintenance organizations. Only a small per cent of the mileage on a state highway system is under construction in any one year, being brought up to today's safety requirements, and our hope in making these road systems handle traffic safely tomorrow lies in more expensive maintenance programs.

No matter where you go it is easy to find places on the highway which were comparatively safe for traffic a few years ago, but which are now the cause, at least in part, of many accidents. These dangerous conditions must be eliminated. Sharp curves should be done away with by relocation or lengthening the radius to one thousand feet minimum and curves having a radius of six thousand feet or less should be given a reasonable superelevation. Especial attention should be given sharp curves adjacent to bridges and underpasses. All main road intersections should be given special attention and blind curves and corners done away with if possible.

Grades should be of uniform width and the shoulders must be sufficiently strong to carry turnout traffic. Shoulders should be wide enough—say 5 or 6 ft.—on all heavily traveled roads so vehicles may be driven out on them and not interfere with moving traffic. We have a law in Michigan which prohibits the parking of vehicles on the traveled portion of the highway. To abide by the law at all times and in all places may mean inconvenience for the driver, but it is a great aid for highway accident prevention and should be adopted by all States. It would be well to note that this requires widening narrow road grades which is usually classified as betterments.

Narrow road surfaces should be widened and a combination of heavy grade and sharp horizontal or vertical curve should be absolutely avoided. The crown of road surfaces should be as flat as drainage conditions will permit.

Slippery road surfaces are always dangerous and if necessary radical steps should be taken to overcome the condition. Ice covered roads should be sanded giving much attention to grades.

"Tightening Up" Gravel Surfaces.—During recent years a lot has been said about corrugations in gravel road surfaces and the dust nuisance so typical of that type. These conditions have been controlled through frequent blading of the surface and application of suitable dust laying materials. I believe, however, that there is another characteristic of the gravel road that is not getting sufficient attention, that being the tendency of gravel to loosen under traffic in dry weather. This condition is the cause of many accidents and it is the duty of all highway departments to "tighten up" these surfaces which can be done in practical and effective ways.

First, extensive resurfacing should be done in the late fall or early spring.

Second, use a natural binder on gravel that does not readily bind up under traffic.

Third, blade to the outer edges any excessive, loose material and this can be drawn in when needed.

Fourth, apply a suitable dust layer.

All maintenance operations should be carried on in such a manner that men and equipment are actually on the road the minimum time. The placing of flags and signs as advance warning to traffic of work being done, should never be overlooked. Maintenance equipment should not be operated against traffic and I would recommend that, as a safety measure, the states consider the matter of having all such equipment painted some one distinctive color.

Public safety and convenience demand that bridges on our highways be maintained at all times in the best possible condition. The failure of a structure or any part is likely to be the cause of a serious accident. Not only should the safety of the structure be beyond question, but the floor surface should be smooth, adequate railings should be provided and approaches should be well maintained and protected by guard rail. To guard against serious deterioration of any part of the bridge, a systematic and thorough inspection should be made at least twice each year. Any bridge being maintained that has an unusually narrow roadway or cannot carry the regulation legal load should be plainly

posted with special signs calling the driver's attention to these limitations.

Great care should be exercised in the selection of detours around roads under construction. As the highway system becomes more fully improved the detour problem becomes correspondingly less. The public is, however, more exacting in this each year and with traffic increasing and the speed limit being raised, State Highway Departments must adopt new standards of detour service.

The Dust Prevention Problem.—The problem of dust prevention on highways is becoming very serious and when traffic reaches 500 or more vehicles per day, a suitable dust layer should be applied in the interest of safety if for no other reason. There are thousands of miles of low type surfaced highways on the state highway systems. To disregard the dust nuisance on such a road burdened with traffic adds not only a very potent danger to the user of the highway and to his vehicle, but the owner of the adjoining property may suffer material damage as well. To overcome this condition on the state highways laden with dust, millions of dollars must be spent annually and highway officials should recognize this and plan accordingly.

This new era of transportation calls for highways that can be used twelve months of the year. There are thirty-six states where snow must be reckoned with and the degree with which these roads can be safely negotiated during the winter months is in proportion to the efforts being made to keep them relatively free from snow.

Snow Removal.—Two-thirds of the world's motor vehicles are registered in these snow states so it is no wonder that with the improved system of highways and the enormous sums invested in motor driven vehicles, the public is demanding open roads for winter traffic. The highway department cannot afford to carry on this work in a haphazard manner. Modern equipment is available, experience in several states has shown it can be done in a business like manner and the roadways maintained in as safe condition as they are in the summer. We must not forget that snow removal is now a public enterprise of growing importance to the economic interests of the country and if snow is allowed to accumulate on the main highways lives and property are at stake.

The checking of overloaded trucks is an important function of a State Highway Department where there is a possibility of the highway system being crippled by such overloading. Every state has many roads which will stand the normal legal traffic with a moderate maintenance expense, but which will break up excessively bringing about dangerous traffic conditions and can be corrected only at high maintenance cost when overloaded trucks are permitted to use them. This is particularly true in the industrial regions of a state where machinery parts and similar materials are carried by motor truck and in these regions a certain amount of truck weighing should be done throughout the year especially in the spring when the frost is leaving the ground and the roads are in a softened condition.

The moving of oversize loads and buildings over a state trunk line highway should be allowed only upon the issuance of special permits by the highway department. The mover should be required to exercise caution and handle his equipment with due consideration to traffic. Companies desiring to place service structures within the right of way limits of a state highway should be allowed to proceed only upon certain conditions prescribed by the department and in some cases bonds should be required. State highway departments should assume the responsibility of prescribing the manner in which the highway and its right-of-way may be used for all such purposes.

The Grade Crossing Problem.—In the grade crossing state highway officials face one of the biggest problems concerning all people. Federal and state highway authorities have taken some very constructive steps and much closer cooperation between the federal government, the states and the railroads has resulted.

The ideal solution for the individual grade crossing is elimination of the crossing by relocation or separation of grades. It is economically impossible to separate all grade crossings and our problem is therefore not one confined to location work and separation designs, but one dealing largely with protection to the traveling public and the problem of maintaining a smooth crossing over the railroad tracks.

The traveling public has the right to expect reasonable grade crossing protection and the state highway department is the instrument through which this must be brought about. In highway design, construction and maintenance, the grade crossing needs special consideration. The perfect pavement across a railroad track has not yet been found, but close cooperation between the highway authorities and the railroads should get good results.

Much can be accomplished by widening the highway grade adjacent to the crossing, providing flat slopes from the edges of the grade, see that the sight distance is good, paint traffic lines on pavement approaches, place advance warning signs and erect suitable automatic signal devices.

Means must be worked out whereby highway and railroad grades may be separated more often than is now the case. Separation structures as a rule cost so much that the number built any one year is very limited. Much study is needed to perfect designs that will cost less to build. Then the states can make greater headway with this problem. Then, too, each state should make an extensive field study of the crossing protection problem, consider the practicability of more adequate protection such as flood lighting and work out a grade separation and crossing protection program.

This problem is not confined entirely to the railroad grade crossing protection and separation, but includes the intersection of important highways for economic reasons as well as for safety.

Warning and Danger Signals.—It is the duty of each state highway department to develop safe roads by elimination of all known dangers insofar as it is practical. The warning of existing dangers should be pointed out by signs and signals. These devices have become quite standardized which is of great importance. All signs and signal devices such as flashing lights, stop and go units, pedestal signals, etc., should not be allowed within the highway right-of-way if they carry commercial advertising.

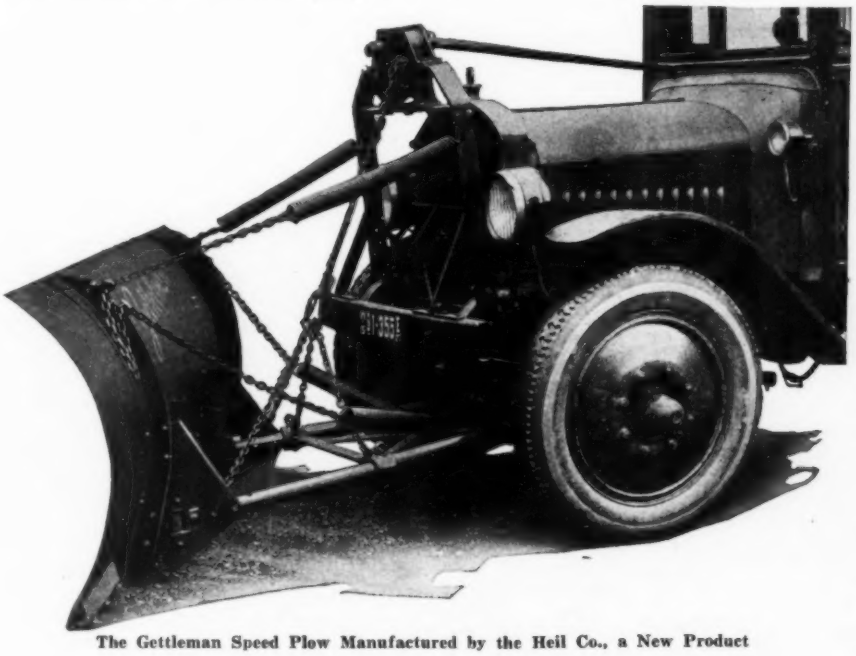
Highway departments should make intelligent studies of the causes of traffic accidents. They should develop a systematic practice for increasing the safety of these roads. This may be through traffic surveys, research, more adequate road design and construction, better maintenance, pavement markings and the installation of signs and signal devices.

Uniform traffic regulations and law enforcement through highway policing is prerequisite to safe traffic conditions. Whether these officers have police powers in general or only the enforcement of the motor vehicle and road and bridge laws, is not a part of this discussion. The responsibility for highway policing in a very few states rests with the highway department and is a matter of state legislation. Regardless of the kind of organization patroling the state highways, it is essential that there be close cooperation between the highway department and the policing body.

In Michigan the state highway department has started a campaign that has for its object the elimination of 150 of the most dangerous points on the trunk line system. This is in addition to an intensive maintenance program which provides for doing away with many lesser dangerous conditions Safety campaigns are as a rule short lived, extending over a period of only a few weeks or months. Would it not be worth while for each state highway department to make a special effort every year that would be accumulative in results and would serve traffic in a most substantial and humanitarian way?

Heil Announces Speed Snow Plow

Highway and municipal officials, truck dealers and operators will be interested in the announcement that the Gettleman Speed Plow is being manufactured by the Heil Co. and sold through the Heil organization. This snow plow is the result of years spent in development of the highway and street snow removal problem. It may be installed on any truck of two tons capacity or larger in about two hours' time. If the attachments are in place, the plow may be removed or attached in several minutes.



The Gettleman Speed Plow Manufactured by the Heil Co., a New Product

The scraper blade is 38 inches high and is built in 9 or 10-foot lengths. Tubular push arms are attached to the front axle, with a universal axle attachment, and the arms telescoped so the angle of the blade may be adjusted to throw the snow to either side of the road.

One of the distinctive features of this equipment is the tripping action of the blade. When the blades hit obstructions which would damage an ordinary plow, it pivots on the pusher arm attachment toward the horizontal position, until it passes the object. Springs then bring it back to the operating position.

In the truck cab a wheel on the end of the control rod provides means of raising the plow to a carrying position.

Two Types of Guard Rail Used on Yosemite Highway

Two types of guards are being used on the Yosemite highway. Stone parapets and retaining walls were built during the construction of the road, and some natural log rails have been built during the past month, both by convict labor. Both parapets and rails blend well with the rugged country through which the road passes.

The natural log rail, besides adding beauty to the highway, is of economical and substantial construction. Trees cleared from the right of way in many districts are successfully utilized for this purpose.—California Highways.

Salvaged Paving Brick Saved Cost on New Job

An old-fashioned pavement at Elizabeth City, N. C., recently presented the city fathers with free material for a half mile of new pavement. It happened that when this old street was paved, some 20 years ago, it was the practice to lay paving brick on edge with no foundation beneath. Built for horse-and-buggy traffic, this street has become uneven under the pounding of trucks and busses. So about a year ago some five miles were scheduled for relaying over a durable and smooth base.

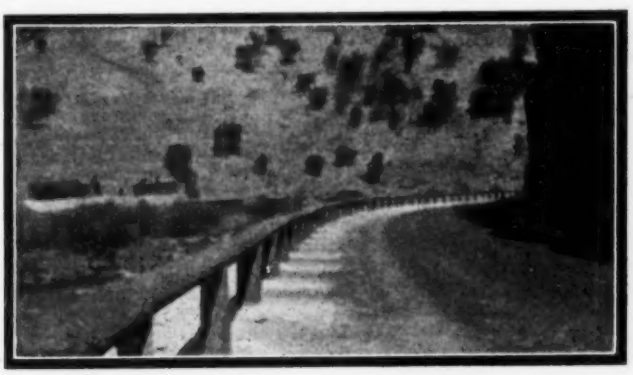
When the old brick were taken up they were found virtually undamaged. Careful inspection proved them entirely suitable for new paving. In fact, the engineers estimated that if relaid they should give satisfactory service for 20 years more.

Accordingly, M. W. Ferebee, city manager, decided to relay these brick over a suitable base in the modern way. It was desirable to turn the brick so that a side other than that which had already served 20 years would furnish the wearing surface. They were laid flat, the method commonly used today, reducing the number needed to surface a square yard. So few of the old bricks had to be culled that without the purchase of any new material the entire old street was repaved and enough brick were left to cover an additional half mile of new pavement. This latter cost the city only the labor of relaying.

Wisconsin to Improve 76 Grade Crossings

Improvements of 76 railroad grade crossings has been undertaken this year by the Wisconsin State Highway Commission with many of these crossings entirely eliminated. As a result of an agreement with the railroad companies who contributed $220,000, twenty-one crossings were improved and the companies have been asked for $40,000 more to continue this work. Projects have also been completed for the diverting of state trunk highway traffic from 55 other crossings.

Left, Stone Parapet Guard Rail on Yosemite Highway.



Right, Guard Rail of Natural Logs on Yosemite Highway.

The Pavement Base Situation

Causes of Failures of Concrete Bases discussed. Preparation of Subgrade. Faulty Concrete Due to Poor Material, Hasty Mixing, Poor Workmanship, Excess of Water, Ignorance or Collusion—Seldom the Last. Increased Richness, Thickness and Reinforcement, from Paper Read Before Engineers' Club Philadelphia

By J. H. NEESON
Chief Engineer, Philadelphia Bureau of Highways

Complaints in regard to street conditions in Philadelphia date back to 1705. In 1720, an ordinance was recommended "to restrain the weight of loaded carriages passing over the pavement." A lottery in 1768 provided five thousand pounds for paving streets and making other improvements. An ordinance introduced in 1854 provided for paving with dressed stone, cobble being the prevailing type before this date. Thirty-seven years later the use of concrete base was recommended; the history of permanent pavements begins with 1892-93. However, the city found itself in 1919 with pavements inadequate both in quality and quantity.

It is of interest to determine to what agency or agencies can be attributed the failure of pavement bases in streets since 1912, when the Bureau of Highways was placed on an engineering basis and its specifications standardized. For the purposes of discussion, we may discriminate between streets occupied by railway tracks, and those not so occupied. Since the underlying causes of failure may be and are different, we have confined the discussion to streets on which there are no street railway tracks.

Failures of concrete base can be attributed to any one or to a combination of the following causes:

(a) Inadequate preparation of subgrade;

(b) Imperfect and improper replacement of ditches and service cuts;

(c) Inferior concrete;

(d) Inability or failure of the top surface to perform its proper function.

Good Subgrade Needed. — In our judgment, too much stress cannot be laid on the necessity of properly preparing the subgrade for the concrete foundation if it is to be expected to accept the uniform distribution of the loads applied to it directly or transmitted through the base foundation. Particular care should be given to this feature of the construction, not only prior to the placing of concrete but during that operation. The existence of any soft, spongy, or loosely bound areas will be as fatal to the life of the concrete base as fill in trenches opened for underground services in neglect to replace in the most efficient manner the advance of the paving or in checking up on older cuts. Lack of the fullest recognition of these important factors has contributed to the failure of street paving in this city and elsewhere.

In an effort to remedy these causes of defects we have recently included in our specifications the clauses that all backfill in open or recently refilled ditches, whether high or low, must be replaced by mechanical tamping. This is intended to cover also those areas of subgrade found to be insufficient to withstand the strain of applied rolling loads.

In practically all contracts for paving or repaving the engineer must contend at some time or other with a condition known as wet subgrade, a difficult feature to control. Much reliance has to be placed upon the judgment of the engineer and the inspectors in charge of the work; hence the human element enters into the determination of fitness or unfitness of the subgrade. The tendency, which is natural, is to proceed with the placing of concrete in order not to delay the progress of the work or, perhaps, to anticipate another change in climatic conditions. It should be an elementary rule in good construction work to make an interruption at this point if it is to be considered of prime importance that the subgrade shall be thoroughly dried out. No criticism can be directed either at the contractor or the engineering forces for this character of delay, even though by taking chances the work could be expedited. The added insurance of competent paving work should be a sufficient offsetting influence against a desire to secure quantity at the sacrifice of quality performance.

The Concrete Base.—It would seem there should be no disagreement regarding the most vital element entering into street paving construction—the preparation and placing of the concrete foundation. Engineers, laboratory workers, and chemical analysts have concentrated their efforts upon the values of mixes and aggregates that enter into the composition of concrete. But we still find evidence of paving failures traceable to base deterioration. If, as has been established by years of experimentation, pre-cast concrete specimens of given depth and diameter do withstand minimum breaking loads per square inch of bearing surface, should such failure be attributed to the known and accepted traffic loads of today? It is, at least, questionable. The debatable accuracy of physical tests of poured concrete as now generally made results in none too dependable classification and is frequently misleading in showing abnormally wide ranges of values in one operation, thus leaving the matter open to a number of conjectures. There is need for more accurate and satisfactory methods in physical tests of set-up concrete in place, tests that will more reasonably determine at once the worth of slab without resort to chemical analysis except as routine check-up. Attention being directed to the modulus of rupture theory in slab or base concrete through work being done by the State Department and by other testing engineers, may result in the abandonment of present practice. But if the physical laboratory test does show beyond question of doubt that the concrete specimen breaks at or below the minimum accepted requirements and chemical analysis indicates a lack of proper proportioning or the absence of cement and aggregates, we are face to face then with a serious defect and perhaps defection upon the part of those in responsible charge of the work.

How do such situations arise? Briefly, they may be summarized as due to inherent weakness of cement or of sand or gravel or stone; too hasty mixing; to poor workmanship in placing; to the excessive use of water; to ignorance or inexperience on the part of the inspector; and finally to deliberate collusion on the part of the inspector and the contractor or his representatives.

A Street Survey.—As a contribution to this discussion the Bureau of Highways within the last fifteen days has made examinations of pavements on eleven streets placed between the years 1913 and 1926, where we had reason to believe base failures might exist. A total of twenty-seven openings were made and it developed that in eight cases the failures were surface failures only and the base concrete was intact; failure in four other instances was found to be due to improper tamping of ditches in advance of placing concrete; three others were evidently caused by poor sub-grade condition; in two instances the concrete base, laid in 1913, had been shattered and from our knowledge of traffic conditions over

the street in question we judge this was due to impact transmitted through surface wear-outs, which the base was unable to withstand. We may state that, broadly speaking, ten of the twenty-seven openings made revealed evidence of poor concrete. Five of these locations were in one street of considerable length and while there were extenuating circumstances in the way of weather and grade conditions, we must reach the conclusion that in the particular locations opened the concrete was of an inferior quality, since on all sides of the opening the concrete was of good quality. Those spots that failed evidently were "lean" and caused by lack of cement or overloading of coarse aggregates, improper water content or too hasty mixing.

The conclusion is upon observation only, as no chemical or physical tests were made; no doubt one, or a number, or perhaps all of the factors enumerated entered into the disintegration of the base. The incident is brought forward here to illustrate the importance of the relationship between the municipality, the contractor and the inspector, and the necessity for intelligent co-operation. It has been the writer's experience that the great majority of responsible contractors do give a dollar's worth of work for the dollar received; and furthermore, only on rare occasions have we found an inspector who is willing to stand by and tacitly agree to a flagrant violation of the specifications. The first requisite of a good inspector is fidelity and loyalty to the responsibility imposed on him.

Too Much Water.—Rather than place too much emphasis on the lack of cement or disproportioning in cases not proven, our observation has been that in the effort of the contractor's organization to make yardage, there are occasions when good workmanship is sacrificed. Mechanical faults creep in. Water is, on occasion, too freely used with a consequent sloppy mix; the period of mixing is not given the attention it deserves—a fact that is quickly demonstrated in the looseness and raveling of the concrete in drying out. A check-up on 60 per cent of the concrete in operation in the month of July, 1926, by an engineer observer of the Bureau showed that on one-half of these contracts insufficient attention was being paid to water content and the average time of mixing was about 45 seconds instead of 60 seconds as called for in the Philadelphia specifications. These conditions were corrected immediately. Assuming that all the necessary quantities of ingredients have been used and in the proper proportion, the strength value of concrete depends almost entirely upon the mechanics of mixing and placing. The time element can be controlled readily and the specifications of the Bureau of Highways for 1927 do not permit the use of a mixer not equipped with a timing device. The variation in time of mixing in ten other cities is illustrative of the differences of opinion of specification makers: New York, Washington, Detroit, Cleveland and Baltimore require the same period as Philadelphia—60 seconds; Chicago, 50 seconds; Boston and Newark, not specified; while Pittsburgh and Buffalo represent the extremes—90 and 38 seconds, respectively.

Closing to Traffic.—As in the case of timing, there is no common standard adopted by all of the eleven cities mentioned regarding the period of protection of new base from traffic. New York, Newark, Buffalo, Boston and Baltimore do not specify the number of days; Washington requires four; Chicago, Cleveland, Pittsburgh and Philadelphia call for seven; while Detroit seems to be taking extraordinary good care of newly laid foundation by putting up the bars against traffic for fourteen days. This feature seems to be either over or under-stressed; fitness to proceed has been regulated mainly by experience and judgment, without resort to any scientific principle. To the influence of climatic changes and speed may be charged reasonable doubt of the maturity of some of our base foundation, less important perhaps than other factors, nevertheless cumulative in the final analysis. Again the fixing of a water-cement ratio should be helpful in removing "greenness" or "ripeness" from the speculative field. The water-cement ratio, now featured in the discussion of concrete as an index to the ultimate value of concrete for plain foundation, ordinary building construction, or more intricate bridge work, may have an important function to perform in paving base of the future.

Wearing Surfaces.—The increase in the volume, weight and speed of vehicular traffic, particularly motor trucks and buses, is bringing out more pointedly the close relationship existing between the wearing surface and base foundation. Modern traffic insists that the surface pavement perform an efficient manifold service—comfort, appearance and ease in cleaning, but shall be primarily an ample protective covering for the base. Satisfactory wearing surfaces for either economy or expediency have been practically reduced in many cities to two types, dressed granite block and asphalt. We have shown in the recent investigation that the disintegration of base concrete in two selected cases was due to the failure of the wearing surfaces. Every pot hole, depression or minor break not only is a potential menace but if allowed to go on without being repaired must eventually cause damage to the foundation from the impact of dropping loads. It is obvious, then, that the wearing surface should be smooth and substantial; it will give service and function properly only in direct ratio to the attention it receives from the maintenance organization. Dressed granite block has shown most satisfactory results in serving modern requirements in this city and has afforded a sufficiently smooth running surface. It has been expedient and economical to use this type of surface in Philadelphia because of the large mileage of streets already covered with granite block on gravel base, permitting the redressing of selected block. With a high resistance to displacement and greater adaptability to uniform distribution of loads, we have found very little evidence of base disintegration under block, except that attributed to poor subgrade or in ditches and cuts replaced some time after repaving. We endeavor to repave in kind—block for block—but expediency also requires that in repaving programs a balance be maintained between block and asphalt, including sections of our main-traveled thoroughfares. Asphalt, although used exclusively on new paving operations, is less hardy than block and shows more quickly the devastating effect of heavy loads. In a greater measure than is the case with granite block, the life of the wearing surface is dependent upon prompt maintenance repairs, although in our investigation we found only two instances where disintegration or possible neglect in making prompt repair was the direct cause of shattering of base. But observation alone, irrespective of the type of wearing surface, will demonstrate the futility of preserving base without periodic maintenance patrol.

Use Reinforcement.—In the above survey we have endeavored to outline what appear to be the major causes for base failures, endeavoring to suggest the corrective measures that might be applied. It seems to be generally recognized, however, that a change may have to be effected in the character of concrete base or improved methods employed to guarantee against failure during normal life. The principal suggestions so far brought forward are an increase of two inches and upwards over the commonly accepted depth of six inches, strengthening of the mix and the resort to reinforcement. The last idea will not find favor in many municipalities, at least not until the day arrives when city streets are laid out boulevard fashion permitting the placing of all subsurface structures in the footways or allocated unpaved areas in the roadways. To a limited extent, placing of reinforcement in base foundation should receive serious consideration. The tendency of track structures, particularly intersection crossings, turnouts and switches, to cause paving defects and consequent irreparable damage to base concrete would seem to warrant in special cases of this kind the use of reinforcing material, not only to protect the base itself but the substructures passing un-

derneath; otherwise, the necessity for intermittent opening up of street paving and the difficulty of replacement from the engineering standpoint does not appear to justify the increased cost of this type of construction. Not one of the eleven cities heretofore mentioned has adopted reinforcement in city street paving. The use of reinforcement may, however, shortly become desirable in the replacement of concrete over service cuts and ditches unless methods now employed to guarantee stability of the backfill prove to be more satisfactory than is now the case.

Several Specifications.—A richer mix, at increased initial cost, may indicate the trend of thought in some cities, as the following data show:

MIX PROPORTIONS.

1:8	Buffalo
1:2:3 to 1:3:6	Chicago
1:6	Cleveland
1:2:4 to 1:3:6	New York
1:2:3	Pittsburgh
1:2.5:4.5 (stone or gravel) and 1:2.5:4 (slag)	Detroit

Note: Compiled data quoted in this paper are subject to correction due to possible recent changes in specifications.

A survey of these eleven cities shows that to date only two, Buffalo and Detroit, have incorporated as a requirement of their specifications eight-inch concrete base; New York, Philadelphia, Pittsburgh, Washington and Newark still maintain the six-inch depth; Baltimore, four, five or six; Boston, Chicago, Cleveland have specified no depth, evidently with the thought of meeting special or variable conditions. Nevertheless there is a growing disposition to believe that increased depth of base is the solution of the problem. It may or may not be. But in the belief that we must provide extra depth of base if we are to have future security in the soundness of our foundation paving, Philadelphia completed two major repaving projects in 1926, using eight-inch concrete base. One was in the water front section where traffic is not only congested but heavy, and the other on a heavily travelled truck, touring car and bus route. Experience has demonstrated, granting that all possible care has been taken in the preparation and placing of 6-inch foundation, that failures do occur. An increase in the factor of safety is inevitable and for that reason we believe we were fully justified in absorbing the additional cost on these operations.

As against the theories are the possibilities of improvements in the methods which may permit us to maintain a foundation of six-inch depth and one that will meet the test of heavy-duty traffic.

The Cost of Extra Thickness.—Any new proposition, involving other than minor changes in specifications, adds to capital expenditure per square yard. A mere increase of two inches in depth of 1:3.6 concrete on a city street, twenty-six feet in width between curbs will, at a conservative estimate add $10,000 per mile to the initial cost. Would a portion of this added cost utilized for new mechanical methods in the placement of base achieve the results we are looking for at less cost? Recently Philadelphia contracted for base paving of standard 1:3.6 mix, including a special mechanically applied surface treatment, producing an indented face for an asphalt wearing surface. In addition to ridging or corrugating the surface of the concrete the method employed apparently "squeezed out" the excess water in the carrying vehicle. A 3½-inch square by 7-inch prism of this concrete was sent to the laboratory and substantiated the claim of a strengthening increment, incidental to the process, by developing a unit compressive strength of 2430 pounds, 62 per cent over the usually accepted figure of 1500 pounds per square inch for this mix. We are not selling this idea; the thought merely occurs that this field of research is still open.

Have we secured the best results with the means at our command? Would the increased cost of additional depth of concrete or stronger mix or reinforcement be absorbed or approached by greater care exercised in preliminary preparation, more rigid adherence to specifications, the reduction to a minimum of the vagaries of human judgment, less speed and better quality in the making and placing of six-inch base? The same elements of uncertainty may and probably will exist no matter what new type of construction is advocated and used, whereas conscientious effort and a betterment in methods both in construction and maintenance may be the measure of the most efficient kind of production at less extra cost and without radical changes.

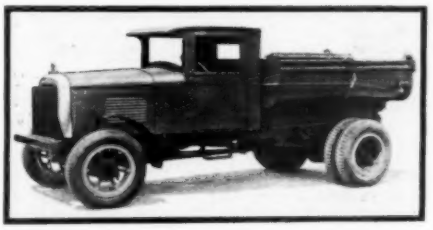
The problem deserves and will receive, no doubt, serious study. If and when changes in type of construction become a part of standard specifications, it would seem that the exercise of good judgment will be essential and necessary as special conditions arise, or when, in the opinion of the engineer, present and anticipated traffic demands are not a part of the consideration of initial costs.

On the other hand we face abnormal conditions in modern transportation, and no one can foresee where the limitations of weight, volume and speed will end. The idea of first cost must be left out of the picture, and we will perforce accept necessary changes in design and construction, building for the factor of resistance upon the same principles as in bridge work and as economically as we may. The end will justify the means.—Public Works.

Indiana Announces New Model Pavers' Truck

The demand for a six-cylinder two seven-bag batch paving contractor's truck has resulted in the design of the Indiana model "615A" Road Builder, just announced by the Indiana Truck Corporation of Marion, Ind. The six-cylinder engine with which it is powered gives smoother power, eliminates vibration, as well as permits higher speed, it is claimed. Chassis of this type in road building work are used principally where longer hauls are required and fewer stops. The total weight is 6,900 lbs. The Model 615-A six-cylinder Road Builder will be furnished with a 60-72 cu. ft. dump body, which is the right capacity for two 7-bag batches, 1:2:3 mix, and also two 6-bag batches, 1:2:4 mix, or two 6-bag batches, 1:2:3½ mix, when the cement is carried in sacks on top of the sand and stone.

This truck has a wheelbase of 136 in. The loading space is ample for the



The New 6-Cylinder Road-Builder Truck Built by the Indiana Truck Corporation

duty required, since the length back of the seat is 7 ft. 4 in., length from seat to center of the rear axle is 4 ft. 9½ in., and the width of the frame is 34 in. Front wheels are equipped with 32x6-in. pneumatic cord tires, while the rear wheels carry 34x7-in. dual pneumatic cords. Turning radius is 24 ft.

The engine is of six cylinders, 3⅜-in. bore, and 5-in. stroke, and of the valve-in-head type. Plain tube 1¼-in. carburetor and manifold hot spot handle the fuel, while ignition is supplied by high tension magneto driven from the pump shaft. Transmission is of the four-speed selective type, mounted in unit with the motor, with a low gear reduction of 5½ to 1. The clutch is of the dry plate type, Raybestos against steel. These and other interesting points are covered by specifications that may be secured from the manufacturer.

The same manufacturer has brought out a similar job known as the Model 111-A Road Builder. It is powered with a four-cylinder motor and equipped with a 1½ cu. yd. dump body (41 cu. ft.), and hydraulic underbody hoist. End gate is double-acting. This smaller truck has a turning radius of 20 ft. The general specifications of this model are otherwise generally the same.

Planning Highway Improvements

Use of Traffic Survey Discussed in Paper Presented 1927 Convention of Association of Highway Officials of North Atlantic States

By W. A. VAN DUZER
Deputy Engineering Executive Pennsylvania Department of Highways

A traffic survey forms the basis of systematic planning for economical and effective highway administration.

Traffic and its analysis are fundamental problems of the highway official. Traffic outlines our highway systems, inaugurates initial improvements, determines type and width of surface, contributes toward maintenance cost, dictates replacements and extensions, and supplies a considerable portion of the revenues to meet its own demands. In short, traffic is the first half of the action and reaction equation in highways, and with the enormously increasing traffic of recent years a thorough understanding of its outstanding features is essential.

Traffic and road expenditures have reached such proportions that positive traffic knowledge is necessary. You deal in facts in your specifications. It is just as desirable to deal in facts relative to traffic.

Present and Future Traffic.—A traffic survey will show present and future lines of transportation and requirements as to width and type of surface.

It is important to make observations relating to future as well as to present conditions. Very little can be done to correct, alleviate, or improve "present" conditions, but careful planning can provide adequate and economical facilities for future traffic. Hence, the analysis of present conditions is to be considered principally as providing the basis for forecasting. To know your present traffic is interesting, but the forecast of future traffic is an engineering necessity.

Prophecies, at least engineering prophecies, are uncertain to a degree, but present standards of durable type reconstruction furnish twenty year, or more, life payments, and we cannot avoid the obligation of anticipating the traffic conditions that will prevail during the latter part of the life of the durable pavements.

Present conditions are ascertained by traffic census, including analysis of volume and weight.

Supplementary data and study determine the relation of traffic to registration—to industry—to population. Forecasting, in reverse order, then estimates population, industry and registration and deduces volume and weight of traffic.

Purpose and Plan of Survey.—Dealing with the practice of the traffic survey, the first essentials, naturally, are the purpose and plan of the survey. A survey without purpose would be waste and a survey without a plan based upon a practical understanding of existing conditions would be either inadequate or extravagant.

The completed traffic survey is not an achievement but rather a tool, and the use that is to be made of the results of the survey must be known in advance if they are to be of full service.

There must be a reasonable balance as to the distribution of the energy and expense of the survey in securing data of volume, weight, nature of traffic and source and destination.

Preliminary Traffic Surveys.—In many cases it is desirable to make a preliminary general survey to supply the information necessary for planning a really useful transport study.

When a preliminary survey is required, it can generally be made to best advantage by the maintenance organization.

The preliminary survey is usually called a blanket count. That is, it simply enumerates automobiles, motor trucks and motor buses by class without differentiating as to the capacity, load, length of trip, or nature of business.

Traffic Stations.—For the preliminary survey, ordinarily, the stations would be placed near the points of entry, on each road, of villages, towns and cities. For general information, a comparatively few counts could be made at intermediate points. A 12-hour count, 8:30 a. m. to 8:30 p. m., will include a large part of the 24-hour traffic, and an occasional 24-hour count will establish the relation between 12-hour and 24-hour counts.

For instance, counts might be made at stations on 26 day intervals so as to provide two counts for each day of the week through the year, and in each three months one of the counts might be a 24-hour count.

This schedule would necessarily be subject to adjustment, as it would not be desirable to make these occasional counts on days which happen to be very stormy or on days when there might be unusual conditions that would draw abnormal traffic on the road.

With the results of a preliminary survey in hand, the number and distribution of traffic census stations for a complete survey and the duration of activity at each station still constitute a problem that requires careful consideration of the disclosed conditions and the final purpose of the survey.

For example, if the system of roads on which the traffic survey is to be made is surfaced throughout, but certain roads are over-crowded or are carrying close to maximum traffic, and the purpose is to determine future responsibility for strengthening and widening certain parts of the system, then the force of the survey should largely be concentrated on the determination of volume of traffic and peak loads on the heavy traveled sections of roads and study of maximum wheel loads and frequency of heavy loads.

On the other hand, if the system of roads in question includes a percentage of unimproved road, light improvement, obsolete type of improvement, or very narrow road, and the survey is to furnish data for use in connection with fixing the relative time of improvement of the unimproved roads or replacement of the inadequate improvements, it should measure total volume and distribution of traffic.

Survey Parties.—A complete traffic survey should be carried on by a well-organized force with parties definitely assigned to make the enumeration of vehicles, and other special parties assigned to gather particular information, such as source and destination of travel and bus and truck weights.

As an illustration, the Pennsylvania Highway Transportation Survey of 1924 covered the principal roads of the State highway system, about four thousand miles, as follows:

STATION LOCATIONS

Pit Scale, Station locations	18
Portable Scale, Station locations	60
Recording Station locations	253

PARTIES

Pit Scale Parties	3
Portable Scale Parties	5
Recording Parties	11
Night Parties	4
Passenger Traffic Party	1

PERSONNEL REQUIRED

	Chief.	Men.
Pit Scale Parties	1	3 to 7
Portable Scale Parties	1	2 or 3
Recording Parties	1	1
Night Parties	1	1
Passenger Traffic Party	1	3

Interpreting the Results of the Survey.—There may be differences of opinion as to what should be considered the governing theory of a traffic survey, but my understanding of it is that the stations should be so distributed that the total traffic on the system studied may be considered to be either the total of the counts at all of the stations or some factor of the total of the counts.

This theory is in line with the reasoning that the ideal condition of a survey would be with a reporting station at the center of each mile of road so that the total of counts would practically represent the total of vehicle miles, ton miles, passenger miles, etc. This would not be feasible from a practical standpoint and location of stations should be made to obtain as near as possible the average traffic results.

Insofar as the stations are judiciously distributed they may be considered representative and the average of the station counts may be assumed to be the total travel divided by the number of miles of the investigated system.

If this theory of the survey is accepted, and the distribution of survey

stations is adequate, then the station counts may be used direct for the determination of vehicle miles, ton miles, passenger miles, etc., but they should be adjusted by use of factors involving length of trip whenever figures are to be deduced for number of vehicles, number of tons, number of passengers, etc., transported.

The distinction is significant and particularly important in studying relation of long distance and short distance travel; for example, domestic and foreign State licensed cars, or short haul and long haul freight.

Forecast.—An estimate of future traffic for any section of road, or any system of roads, can be built up from traffic survey notes.

Experience indicates that the average annual travel mileage per motor vehicle is about the same from year to year, or shows a slight gradual increase in annual mileage.

Observations in widely separated states confirm this. In Maine, 1924 motor vehicle registrations were 232 per cent of 1919 registrations, while 1924 traffic was 229 per cent of 1919 traffic. In Wisconsin, corresponding 1924 percentages were 222 for registration and 288 for traffic. Therefore, if we know present traffic, and can estimate future registrations, we can approximate future traffic.

If no direct count is available, and if there is no nearby station from which approximation can be made, present traffic can be estimated by listing the population of towns and townships served, and applying factors that have been determined, ratio of motor vehicles to population, and ratio of traffic to registrations. In most cases, these ratios will be determined separately for each county.

The future registration is to be estimated by producing census figures for the area and making assumption as to the ratio of motor vehicles to population.

Studies of hazards and bottle-necks, and examinations as to possibilities for development of parallel and by-pass routes, are included in a comprehensive survey, and a very important phase of the survey is the study of local industries and trends, which is helpful, especially with reference to truck traffic.

Section Plotter That Iowa Has Adopted

A new section plotter that has been adopted as standard for preliminary and construction work by the Iowa Highway Commission, and that is already being used in a number of other engineering offices, has recently been announced by R. McCormick, 812 Ridgewood Ave., Ames, Iowa. This device for plotting cross sections, known as the Ames Section Potter, plots rod readings direct from instrument heights, and serves as a convenient guide to locate each cross section point on the cross section paper.

The plotter is made up of three parts. The number sheet which is placed beneath the transparent cross section paper and which is visible through it, gives a visible scale of distances out from the center line in each direction. A "T" square comprises the second part. The third part is the Slide, with rod reading plotting scale attached, graduated to plot either plus or minus readings. The parts as manufactured are for plotting successive vertical columns of cross sections on a roll or on sheets of transparent 1/10th inch cross section paper to a scale of 5 ft. vertical and 5 ft. horizontal per inch. Other scales may be supplied upon order. With this device, it is only necessary to compute the elevations of the center line for each cross section.

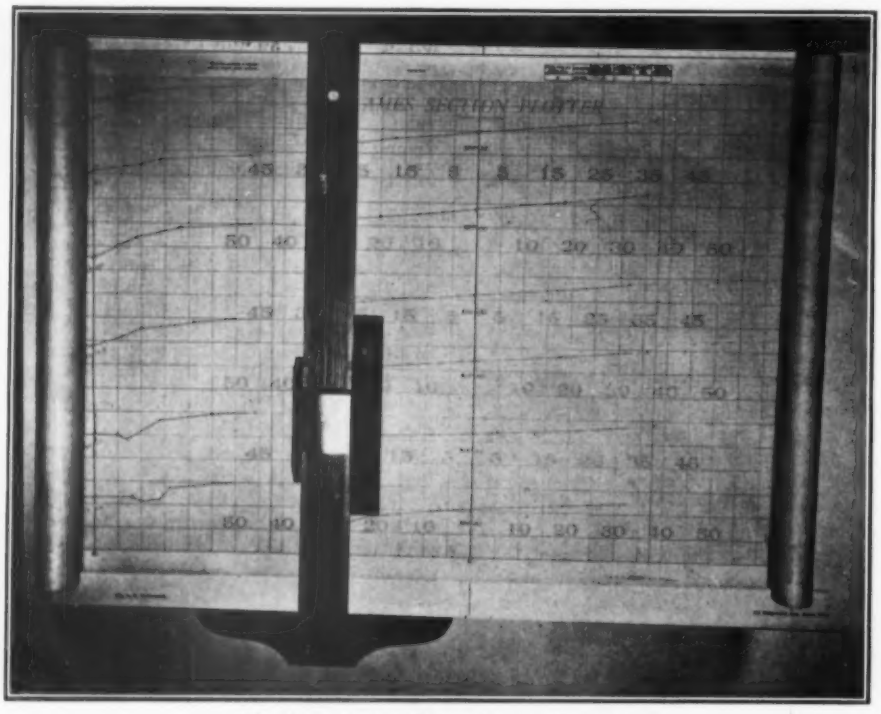
To use the device, the number sheet is first placed on the drafting table, making the horizontal line parallel with the front edge of the table by means of the "T" square and scale. The sheet is then secured with thumb tacks. The cross section paper is then superimposed on this sheet, using the vertical line to properly locate the section column center line and the horizontal line to orient the horizontal ruling parallel with the front edge of the table. The "T" square is then placed on the cross section paper, with the slide attached, and the head against the front edge of the table.

At the bottom of the cross section column then plot the computed centerline elevation of the first cross section, record the station number and assumed datum. Move the level rod scale up the blade of the "T" square until the zero coincides with the nearest half-foot to the computed instrument height. This setting brings each graduation on the level rod plotting scale coincident with a horizontal ruling on the cross section paper.

To check this setting compare the plotting scale intercept, between the zero and the plotted centerline elevation, with the recorded note book reading for the same point. Make sure that this intercept reading differs from the note book reading by the same amount that the half foot setting differs from the true instrument height.

To complete the plotting of the cross section, move the "T" square, without distributing the setting of the scale, to the left and plot the successive rod readings plus or minus the difference between the computed H. I. and the half foot setting. Then move the "T" square and plot the right hand readings. Plot the next section by moving up the column, and when the column is completed advance the cross section paper and start the next column in the same manner.

With one person reading and another plotting, the manufacturer claims that sections may be ploted at the rate of a section a minute.



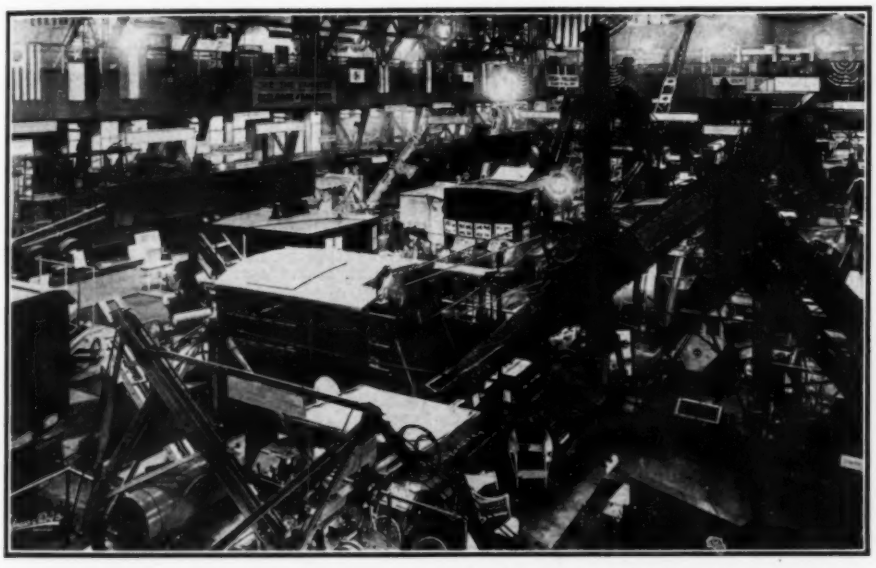
The Ames Section Plotter Set Up For Use

25th Annual Convention of American Road Builders' Association

An Outline of the Road Show and Convention to Be Held Jan. 9-13 at Cleveland, O.

This year is the 25th anniversary of the American Road Builder's Association. The convention and Road Show that will be opened by President C. M. Babcock in Cleveland, Jan. 9, 1928, will be testimony of the progressive change and great development that have been brought about in the Association during the past few years.

Years ago the convention, made up almost entirely of engineers, discussed the economy of roads and showed the best methods of construction; later the convention spoke of maintenance, but not as the important and ever present problem that it is today. Now, in addition to the latest methods of construction and maintenance, the convention presents the solution of the problem of traffic control and highway operation in the light of most recent developments.



View of the 1927 Road Show, Showing a Portion of the $3,000,000 Exhibit. It is Expected the Cleveland Exposition Will be 50 Percent Larger than that Held at Chicago

Several years ago some of the equipment manufacturers began exhibiting some of their products to the engineers and contractors attending the convention. This proved to be a great advantage, not only to the equipment producers but to the highway engineers, officials and contractors; and it became a regular practice to show road equipment at the Road Builder's Annual Convention. This was the beginning of the road show.

During the past few years, due to extended organization, the American Road Builders' Association has come to represent the highway industry—the maker of the highway as represented by the engineer, official, manufacturer and contractor, as well as the user of the highway, as represented by the general public.

At the convention the latest methods of construction, maintenance and operation are presented by carefully selected authorities. The Exposition affords an opportunity for the engineer, official and contractor to see and compare in a few days the latest developments of road equipment and materials as produced by over three hundred manufacturers. The road show is also of a distinct advantage to the exhibitor, for it is an opportunity to present and display within the period of a few days his latest developments in equipment and materials to some 25,000 delegates comprising representatives from every state in the Union as well as many foreign countries.

With such mutual advantages, it is no wonder that the Road Builders' Convention, due to the serious interest of all attending, has changed during the past few years to one of the outstanding institutions of highway education and exposition.

There was a time when a road convention might have been considered an occasion for a vacation, but it is now regarded as the clearing house of latest developments in the highway industry. Entire commissions and boards are attending or sending their staffs, for it is clearly seen by them that the information secured at the convention and road show will, in its application to local problems, offset many times during the year any expenses incurred by them in attending the convention.

Each year from the standpoint of educational advantages the convention and road show grows. Carefully selected highway authorities, always eager to make contributions to the art of road building, present well-designed papers. Manufacturers, wishing to present in an educational way their latest improvements, have long regarded the road show as the time to present their new productions to the highway public.

The convention will be marked by four significant days. Monday, Jan. 9th, will be manufacturers' day and will give ample opportunity for the manufacturers to present their newly-developed products to the visiting members of their own organizations from different parts of the United States, as well as their visiting distributors who are depended upon to carry the new developments of the manufacturers into their local fields.

Tuesday, Jan. 10th, will be Governor's Day. Governor A. V. Donahey of Ohio will be Honorary Chairman of the day.

Wednesday, Jan. 11th, will be Pan-American Day and the program is given over to the special problems important in all countries, as well as the development of closer relations with the Pan-American countries, especially in regard to their highway programs. Dr. E. Gil Borges, Assistant Director of the Pan-American Union, is Chairman of Pan-American Day and his close identification with the Pan-American countries assures the greatest success for this day.

Thursday, Jan. 12th, is County Highway Officials' Day. The newly-organized division, under its President, Thomas J. Wasser, will have charge of the program for this day. The county division is functioning through eight standards committees, covering the county highway problems. Papers and reports of these committees will constitute the program of this day and all activities will be carried on by county officials. The County Highway Officials' Division is growing fast and gaining a large membership. Several hundred contact men have already been appointed and will act as delegates to the convention.

Friday, Jan. 13th, will be given over entirely to the road show, so that engineers, officials and contractors who have devoted their time to listening to the papers at the convention will have an opportunity to visit the road show and inspect and compare the latest developments in equipment and materials.

The program of the convention will be coordinated by H. K. Bishop of the Bureau of Public Roads. He will be assisted by Frank Sheets and Fred White in the engineers' sessions and S. M. Williams and Gen. R. C. Marshall in the contractors' sessions. President T. J. Wasser of the County Highway Officials' Division, assisted by Vice-President of the Division, Chas. E. Grubb, will have charge of the program on County Highway Officials' Day.

The program will have sessions selected for the interest of engineers and

officials and sessions selected for the particular interest of the highway contractors. On County Highway Officials' Day the entire program will be of special interest to the county officials.

The convention sessions will be held in the Hollenden Hotel, which is but one block from the road show.

The question of organizing a City Officials' Division will be considered at this convention.

The road show this year will be greater by far than in preceding years. Arranged in Cleveland's beautiful Auditorium, with every exposition convenience and a large floor area, the exhibitors will have opportunity for the first time to show more equipment in such a way to be of additional value to the visitor. A large number of new exhibitors, who in former years have been unable to obtain exhibition space, will make the road show of added value and round out the exhibition of road equipment and materials.

On Wednesday evening, Jan. 11th, Pan-American Day, there will be held the Road Builders' Banquet, limited on account of the size of the banquet hall to 1,200 people. Each year the popularity of this occasion has grown and attracted favorable comment. Delegates from Pan-American countries will be guests on this occasion, which marks the close of Pan-American Day.

The exposition will be open Tuesday and Thursday evenings and there will be a general entertainment at the auditorium on these evenings. On Monday evening a special reception will be held by the association for the 112th Regiment of Engineers; the County Highway Officials of Cuyahoga County, Ohio; the officials of the City of Cleveland and the officials and members of the Ohio State Highway Commission and on this evening the Exposition will be open for them and special guests of the exhibitors.

There will be practically every kind of road equipment and material displayed at the convention. Producers of large equipment have several innovations that they will present and there will be shown at least two new pavements.

All hotel reservations must be made through the Hotel Committee, A. J. Kennedy, Chairman, 304 Chamber of Commerce Building, Cleveland, O. Assurance has been received that all attending the convention will be suitably provided for in hotels. Hotel reservations should be made direct to Chairman Kennedy.

There have been rumors to the effect that the hotel accommodations in Cleveland would not be sufficient to take care of those attending the convention and road show. The hotel committee wishes to take this opportunity to announce that the hotel facilities in Cleveland will be ample to take care of all who attend the convention.

The attendance at the convention and road show has been steadily increasing. Last year 19,000 people registered, denoting an attendance of over 25,000 people. This year stricter registration will be obtained in order to secure the names and permanent addresses of the delegates, so that information about future conventions may be mailed to them.

Due to the increasing number of members in the American Road Builders' Association, the membership has been divided into five divisions. These different divisions will be distinguished by different colored badges, obtained when registering at the convention. The Division of County Highway Officials includes all engineers and officials associated in county work. The Division of Engineers and Officials includes all engineers and officials in state or municipal work or in private practice. The Division of Highway Contractors includes all contractors active in highway construction. The Manufacturers Division comprises manufacturers making a specialty of products used in highway work and includes primarily the exhibitors. The Membership at large includes all classifications not covered in the four other divisions.

The dividing of the membership into divisions seems to be of special value because the members of the various divisions may concentrate their activities and time on the work of a particular division. It often happens that one division is desirous of developing activities not of especial interest to other divisions. The coordinated activities of all the division assembled at the convention and road show will be of the greatest mutual advantage to those identified in the highway industry.

Reduced railroad fares have been granted to those attending the convention. When purchasing ticket to Cleveland, a certificate (not receipt), should be asked for which will entitle the purchaser to a return ticket at one-half price.

There will be separate headquarters both at the Public Auditorium and at the Hollenden Hotel for the state highway officials; city officials; county highway officials and highway contractors. All delegates are invited to register and use these headquarters while at the convention. Attendants will be in charge at all times.

Iowa County Will Vote on Road Bonds

The Iowa State Highway Commission has approved Iowa county's proposed $900,000 bond issue for paving U. S. highway No. 32 across the county, No. 49 from Williamsburg to No. 32, and No. 49 from North English to four miles north, together with grading, graveling and bridging on other primary roads. An election will soon be held at which this bond issue will be considered by the voters.

Paving Done by South Carolina in 1927

The paving projects let to contract by the State of South Carolina since Jan. 1, 1927, including those upon which bids are to be received Dec. 13, total 529.156 miles, according to a recent announcement issued by C. E. Jones, chairman, State Highway Commission. The mileage is given by counties.

Estimating the average per mile cost of the paving at $24,946, the figures so far for this year, it will be observed that a total of $13,200,517.35 will be obligated in 1927 for hard-surface roads in South Carolina. This amount does not include contracts, aggregating several million dollars, executed in 1927 for earth type roads and bridges.

Paving projects let to contract since Jan. 1, 1927, and those upon which bids were received Dec. 13:

County	Miles
Aiken	3.091
Anderson	7.900
Beaufort	22.400
Berkeley	35.311
Calhoun	6.000
Charleston	12.018
Cherokee	16.500
Colleton	35.000
Dillon	14.455
Dorchester	22.329
Florence	34.921
Greenville	30.407
Greenwood	24.060
Jasper	30.618
Kershaw	22.168
Lexington	36.720
Marion	23.583
Newberry	12.085
Oconee	16.299
Pickens	5.825
Richland	20.517
Saluda	43.409
Union	9.509
Williamsburg	28.000
York	16.036
Total miles	529.156

Paving projects let to contract since Jan. 1	404.356
Paving projects on which bids were received Dec. 13	124.800
Total for 1927	529.156

Cost of paving let to contract, 404.356 miles, $10,087,256.55, or $24,946 per mile.

Estimated cost of paving projects, 124.8 miles, on which bids are to be received Dec. 13, applying same average of $24,946 per mile, $3,113,260.80.

Total cost and estimated cost for paving let and to be let to contract in 1927, $13,200,517.35.

Moreover, the paving cost for 1927 averages $5,054 per mile less than the figures accepted in 1924 and 1925. It was thought then that $30,000 per mile would be required to pave the state highways. If the projects on which bids are to be received Dec. 13 are let to contract at the same average per mile cost or less, the saving to South Carolina taxpayers on the 529.15 miles of paved roads placed under contract in 1927 will total $2,674,344.42.

Keeping Highways Open in Winter in Ontario

Experiences in Snow Removal in Canadian Province Described in Paper Presented Before Canadian Good Roads Association

By A. A. SMITH
Assistant Chief Engineer, Ontario Department of Public Highways

Previous to the year 1920 the highways were kept open for sleigh traffic only and a small amount of money was expended for this purpose. Horse-drawn snow plows, wide enough to pass sleigh traffic, were used in the heaviest travelled section. Hand shovelling was done where drifts were deep, or the traffic was diverted through fields in order to get around drifts. In some sections wooden snow rollers were used.

During the winter of 1920 a more organized attempt was made to keep the roads open for motor traffic, especially in the proximity of towns and cities. Horse-drawn graders were used where the snow was not excessive and hand shovelling was resorted to in heavy cuttings. That year the department spent approximately $1,486.

In 1923 it became more apparent that still more of the highways had to be kept open for motor traffic. We commenced erecting snow fences and the purchasing of more snow clearing equipment. We attempted keeping the road open from Toronto to Oshawa in the east and from Toronto to Niagara Falls in the west, a total distance of 140 miles.

Since 1923 each year has brought its increased demands from the travelling public for more open roads, so that last year the Department actually kept open 800 miles of highway, ranging from Windsor to Kingston, with areas around Ottawa, Niagara Falls, London, Guelph, Kitchener, Stratford and other important points. The cost amounted to about $68,500.

The department is being asked continuously now by trucking firms, bus companies, etc., as to which roads will be open during the coming winter, in order that they may make their contracts with industrial firms and provide good service to the general public.

It is essential that our engineers and their patrolmen study the roads each winter, with a view to determining where the drifts generally occur and their cause. Often drifts are caused by old hedges, snake and other kinds of fences. Arrangements are made to have these removed and replaced by a new type of fence, which has less tendency to collect the snow.

Snow Fences.—The erection of approved snow fences is the next step towards keeping roads open and by continuous observation, points are selected where drifts usually occur. Permission has then to be obtained from property owners for the erection of the fence, which has up to now been gladly given free of cost with the understanding that the fences are removed before cultivation begins in the spring.

In erecting the fences it is advisable to have them firmly set in position before the ground is frozen. We try to get them all in place not later than the end of November. We find that the best position for the fence is about 100 ft. from the center line of the highway. This leaves room for the snow to pile between the fence and the outside of the highway ditch, leaving the ditch to be used as a piling ground for the snow to be removed from the road bed.

Up to the end of last year the department erected about 50 miles of various types of snow fences in different parts of the country and it is expected that we shall erect about 100 miles of it this season. We have tried many kinds of fencing, varying in height from 4 ft. to 8 ft., but we now favor a picket fence wired together, which is 4 ft. high and fastened to the ordinary steel fence posts. This fence is easily erected and removed. It can be rolled up and stored away quite easily for use the following year. The cost of this fence erected is about $1.50 per rod. The higher type of fence often gets blown down and broken, and it costs much more to construct, erect and store.

Organization for Snow Fighting.—By Nov. 1, all snow fighting equipment which has been in use during the summer on construction work should be brought in for a thorough overhauling. Divisional points must then be selected where the equipment can be stored in well heated buildings and, if possible, the men operating it should be housed close by. This organization should be complete and ready to go to work any time between December 1st and 15th, but not later as often we get a snow storm in December that will lay a bad foundation for the rest of the winter. The men must hold themselves in readiness to go out on the road at any minute during the night or day and they must be working on the road throughout the entire storm.

It has been found that one organization properly located and equipped can efficiently handle about 75 miles of road. In this connection it might be advisable to make use of the meteorological service by having it wire the different divisional points when any severe storm might be expected.

Equipment for Snow Removal.—On roads in the south-westerly part of the province, where snow seldom gets very deep, we have operated very successfully with horse-drawn graders and small blade ploughs, but where there is any real snow to face, it is advisable to obtain the best equipment, which in the long run is the most economical. All snow ploughs should be equipped with the best of headlights as most of the important work is done at night. In removing snow it is advisable to leave not less than three inches of snow on the road surface, so as to enable any sleigh traffic to use the road.

The department has confined itself more or less to the use of 4-wheel drive trucks, these machines being equipped with a V-shaped blade. The trucks are equipped with suitable extensions to the plough, long and high enough to throw any snow away from the back wheels of the truck and if possible off the road altogether into the ditch.

Unless the entire road surface between the ditches is swept free of snow, the next storm may block the road so badly that the work already done has been wasted and will greatly increase the cost of keeping the road open. The snow must be thrown into the ditches or between the ditch and the fence. A plough of the above mentioned type will make an average speed of 12 miles per hour in, say, 18 in. or 2 ft. of snow.

Use of Rotary Plow.—Should the snow get so deep that this blade plough has difficulty to operate, it is then advisable to use a rotary plow, there being several good types now on the market. This machine should be part of the snow fighting equipment stored at the divisional quarters and should be used only when the snow is very deep or where it is necessary to throw the snow a considerable distance from the road. It may follow the blade plow and throw the snow at the edge of the road into the ditch. In some places where a radial railway line runs along the highway, it will be necessary to throw the snow a considerable distance from the road. It may follow the blade plow and throw the snow at the edge of the road into the ditch. In some places where a radial railway line runs along the highway, it will be necessary to throw the snow right across the tracks.

In addition to our snow fighting organizations the bus and trucking companies have cooperated with the department. In many cases we supplied them with a blade costing about $500, which they placed on their own trucks and operated on certain roads both day and night at their own expense.

It is anticipated this year that the department will endeavor to keep open most of the older portion of the provincial highways and some of the more important new ones recently assumed, with the exception of the ones in the more northerly section of the province, where the traffic is still light and the snow extremely heavy.

Our object is to keep the main highways open for all traffic for 12 months in the year and not to have them idle for even a single day.

Estimating the Highway Contractor's General Expense

Indirect Cost Items Discussed in Public Construction News

By A. H. HUNTER
Engineer, Illinois Association of Highway and Municipal Contractors

The general supervision of construction work requires the operation and maintenance of a home office. In the case of operations at a distance from the home office, field offices will be necessary. The expense of a field office will not be considered here, for in our estimating assumptions we have assumed that work under construction is within easy reach of the home office. The expense involved in the home office is difficult of distribution as it must be divided and charged to the several pieces of work handled each year.

The item of general expense has not received a great deal of attention due to the irregularity of the work. Seasonal changes and fluctuations in the volume and character of the work make difficult the estimating of the cost of supervision. In the absence of experience it is recommended that an accurate record of these expenses be kept and at the end of the year pro-rated to the several sections of completed work according to the value of each contract or upon some other simple basis. Division of this total sum may be made on the basis of price of contract, volume of work completed or such other rational division as may suit the convenience of the contractor. Many contractors find it of value to know what this general office expense amounts to and charge it directly at so much per square yard against the pavement, or so much per cubic yard against excavation handled. It will be appreciated that there are other units of completed work which should rightly bear their proper portion of the expense.

Items Included in General Expense.—The items constituting indirect cost or general expense may vary in each organization. The following are given as fairly representative:

Office—If owned, charge depreciation and repairs.
If not owned, charge annual rental.
Fuel, Light, Water, etc.
Supplies—Stationery and Postage.
Telephone and Telegraph.
Furniture—Its depreciation and repairs.
Traveling Expenses—Not chargeable to any particular job.
Incurred by bidding on unsuccessful projects.
Private Car—Its operation and depreciation.
Organization—
Contractor's annual salary or drawing account.
Accountant or bookkeeper.
Stenographer.
Attorney Fees.
Engineering Assistant.
Auditor—Annual audit.

Middle Course Recommended.—The actual expense of conducting a contracting business involves many items that can be reasonably foreseen and properly estimated. Too often contractors are inclined to group the above items, together with many others, under the heading of Overhead. In general, we believe that these items will suggest a reasonable basis for estimating purposes or compilation of cost records. We cannot predict the inclination of the individual, but it is certain that contractors exist between two extremes—having an elaborate office or having no office at all. Some will maintain adequate office space with a system of books and records, a clerical force and equipment, which in their judgment are necessary for the proper conduct and accounting of their business. Other contractors operate on a hit or miss basis with no practical knowledge of the expense involved. A middle course is recommended. Do not let the expense of the general office eat up your profits. Neither should a contractor be proud of the fact that his office is his vest pocket. Failure to know accurately the expenses of your business makes more certain the probability that sooner or later your banker or your bondsmen will assist some morning in balancing your accounts.

Past experience indicates that if bids had been made intelligently and had included all of the proper items of cost commensurate to cover the risk particular to highway construction, so many failures could not possibly have occurred. Many men would still be in contract work who have now ceased to operate or have transferred their activities to other lines of endeavor. This opportunity is taken to point out to you data that have been obtained in connection with contractors' activities in the State of Missouri. Out of a total of 359 individuals or companies doing work, 51 per cent lasted only one year. Of the 23 contractors who received awards of state work in 1920 only 13 per cent received awards in the season of 1926.

Explanation of General Expense Items.—The foregoing list showing the several items included in office expenses is self-explanatory.

The item of traveling expense, however, is deserving of some consideration. Many contractors lose sight of the fact that the expense incurred traveling from section to section is enormous. If they would give the matter due thought they would be amazed at the amount of money spent each season. The very nature of the work calls them away from home at all hours of the day and night, and the accepted practice of occasional meals for business associates or others connected with the work also swells this expense.

Traveling expense incurred in bidding sections on which the contractor is unsucecssful is an item worthy of some thought. It is a known fact that in periods of depression or times of prevailing low prices, many sections of work will be visited and investigated fully before a contract is secured. Recently, a contractor doing business in Illinois who endeavored to keep two construction outfits busy submitted bids and filled out proposals on a volume of work aggregating more than $16,000,000. Even then he did not secure sufficient work to prevent some idleness of his construction equipment.

The operation of an automobile is just as vital in this industry as any other. Its operation, maintenance and depreciation are items that should be taken into account in general expense.

The Drawing Account.—The personnel necessary for the proper conduct of work should be especially considered. This will vary like the other items, depending upon the judgment of the contractor himself. A contractor engaged in the conduct of his work is entitled to direct consideration for his services. It is true he can balance the arrangement and take the item into consideration when estimating his profit on particular items of work. Whether a salary is or is not allowed is inconsequential, but a drawing account on the bank is indispensable. The need for subsistence of a contractor and his family is an expense that must be met during the progress of the work. In many instances construction companies exist under corporation form with paid officers. In this case, direct salaries for those operating from the general office should be charged in full. Occasionally partnership corporations are formed, and a drawing account is open possibly for the use of both partners. Past practice has developed that it is most satisfactory for each partner to draw a monthly salary.

No one could question the desirability of an accountant or bookkeeper and

if the work is of an appreciable volume a stenographer may be necessary.

Experienced contractors have been inclined to provide themselves with adequate legal advice. As one man expressed himself, he preferred to employ an attorney to keep him out of legal difficulties rather than one to defend him when suit had been instituted. Claims, adjustment of liens and collection of outstanding accounts are items that require occasional legal opinion.

The Contractor's Engineer.—It has become the practice in recent years to employ at times competent engineers to assist the contractor in determining quantities or estimating his work. This engineer is also valuable in the field. In some communities the development of private engineering service has been so pronounced that consulting engineers are specializing in that field. At the present time it is impossible to predict the trend—whether the engineer will be incorporated as a member of the organization or his services secured indirectly through the employment of consulting engineers.

Accurate Accounts Needed for Tax Purposes.—Since the war each contractor is obliged to prepare a financial statement showing the items of profit and loss at the end of each construction season and present the same to the Federal Income Tax Bureau. To make even a reasonable approximation of this statement accurate accounts must be kept, requiring a bookkeeper and accountant. In addition experienced contractors will employ a certified public accountant in the preparation of this annual report. This affords advantages:

First, it assists in the preparation of the account and its presentation to the Federal Tax Bureau.

Second, it is a check upon the accounts and records of the bookkeeper or accountant employed by the contractor.

Third, it gives the impression of the soundness of the financial structure when the report is properly prepared and arranged by one experienced. A contractor with an established reputation imparted the information that at the time his books were first gone over by an auditor he questioned many charges and the soundness of the methods employed, but each year he became more and more convinced as the books were audited that the methods used were sound. In brief, a fair, unbiased study of accounts by a competent man will do much to improve the contractor's understanding of the financial structure of his business.

This discussion of indirect cost as covered by general expense divides itself two ways:

First, keeping adequate records so that in future years the contractor may enjoy the benefit of known expenses in preparing estimates.

Second, without adequate indirect cost records, some estimate must be made in preparing a bid.

Annual Expense Total 2 to 3 Per Cent of Contract.—A study of contractors' annual expenses has been undertaken from time to time by various organizations and in particular by groups of highway contractors. Available records provided by those engaged in highway work indicate that this item of general expense will cost between 2 and 3 per cent of the total amount of a contract, varying between these limits somewhat in proportion of the amount of labor. In other words, those sections of work emplying the most labor will be the most difficult and expensive to handle, whereas sections running high in materials and low in labor will be found to operate at a lesser expense. For estimating purposes we have chosen to use 2 per cent of the total contract price as a reasonably fair basis. Do not be confused and include any other items of general overhead which are distributed elsewhere in this estimate. To keep the cost within the estimated per cent suggested, items of expense should be confined to those suggested previously in this article. A compilation of information worked out by the Associated General Contractors of America also recommends that these are fairly representative figures.

There is no question that contractors always make allowance for materials and labor in any estimate of construction cost. Briefly, these expenses are tangible and direct. At the same time, the more indeterminate items of expense, such as are included in general office cost, are often neglected. It is evident that unless the actual overhead cost is known or can be closely estimated in calculating each bid only the happiest combination of circumstances will make possible the realization of the profit to which each contractor is entitled.

Speed of Up-Hill and Down Hill Traffic on Curves

An investigation of the speed of traffic around curves made by the California Highway Commission is summarized in July California Highways by Earl Withycombe, assistant construction engineer. The investigations were made on grades of 6 per cent and indicate that little or no difference is found in automobile traffic traveling either up or down grade or on either inside or outside of curves. Truck traffic travels considerably faster on the inside of curves both up and down grade, but most noticeably on the down grade sections.

The observations were taken at San Juan grade, Division V SB-2A, Conejo grade, Division VII Ven-2B and Chalk Hill grade, Division VII LA-2B. Average automobile traffic moved up grade at the rate of 21.4 miles per hour on the outside of curves and 23.6 miles on the inside. Down grade the average was 22.2 miles on the inside and 23.0 miles on the outside of curves. Average truck traffic moved up grade at the rate of 9.3 miles on the inside and 8.0 miles on the outside of curves. Down grade they averaged 16.2 miles on the inside and 11.4 miles on the outside of curves.

As nearly as possible similar conditions were selected in each case. Radius of curves ranged from 120 to 275 ft. Central angle ranging from 60 to 160 degrees per cent of grade was uniformly 6 per cent. Super-elevation was from ¾ in. to 1¼ in. per foot of width. Pavement in two cases was 20-ft. width of bare concrete and in one case 15-ft. width of bare concrete with a 3-ft. bituminous macadam shoulder on the inside of curve.

Road Convention Program

An exceptionally interesting program will be presented at the Convention. The subjects on the program are being coordinated by Mr. H. K. Bishop, of the Bureau of Public Roads.

Governor A. V. Donahey, of Ohio, is Honorary Chairman for the opening day, which is "Governors' Day," and President C. M. Babcock will act as Chairman.

In the afternoon session, the Engineering Division will be arranged and in charge of Mr. Fred White, State Highway Engineer, of Iowa, and the Contractors' Division arranged and in charge of Gen. R. C. Marshall, of the Associated General Contractors.

Wednesday, Jan. 11, is Pan-American Day, and Dr. E. Gil Borges, Assistant Director of the Pan-American Union, is Chairman. Invitations have been sent to Pan-American engineers to prepare papers covering the highway situation in the several Pan-American countries. A large Pan-American delegation is expected. In the afternoon a special program will be arranged for the Pan-American group.

In the afternoon the Engineers' Division will be in charge of Mr. Frank Sheets, Chief Engineer of the Illinois Highway Commission, and the Contractors' Division will be in charge of Mr. S. M. Williams, of the Autocar Company.

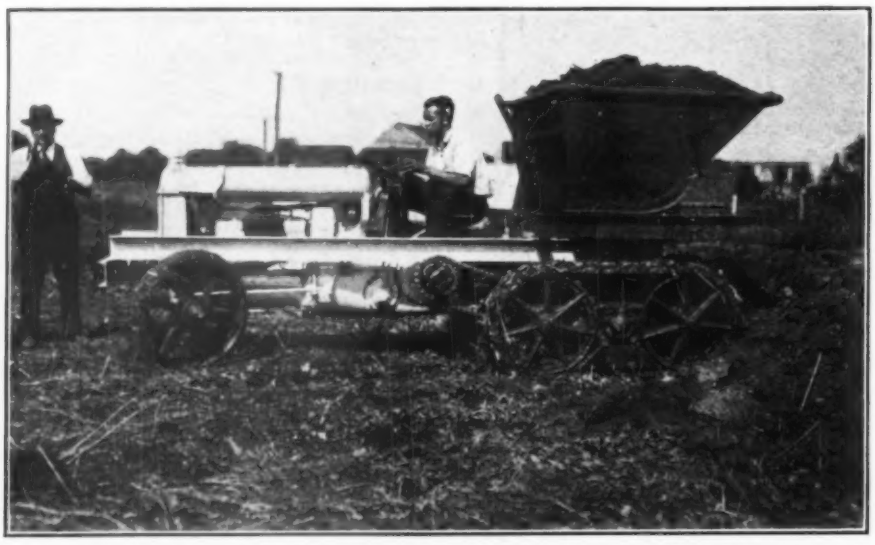
Thursday, Jan. 12, will be "County Highway Officials' Day," and the president of the Division, Mr. T. J. Wasser, is preparing the program which will consist of papers prepared from the reports of the County Standards Committees.

The afternoon session will be presided over by Mr. Chas. E. Grubb, Vice-President of the Division.

There will be included in the program of the Road Show an index of all products manufactured by the exhibitors.

A New Crawler Truck Now Available

A new piece of equipment, known as the Law Creeper Truck, has just been put on the market by the Law Manufacturing Company, 236 West 55th Street, New York City. This truck is of a type that is fast gaining popularity, although the Law Creeper Truck is stated to be the first offered at a price that is within the means of the small operator.



The Law Creeper Truck Is an Unusual Machine, According to the Manufacturers

The Law Creeper Truck is powered by the Fordson Tractor, the efficiency of which as a power plant is universally accepted. The creeper wheel is of the rigid, self-suporting type, so designed as to eliminate the numerous rollers found in most crawlers, and their absence in the creeper wheels means that the friction has been reduced to the minimum. The only rollers in the creeper wheel are the Hyatt Bearings in the wheel hubs. The creeper track is said to be non-clogging, even in the deepest mud. It is equipped with a pressure lubricating system. Adjustment is effected by means of excentric bushings.

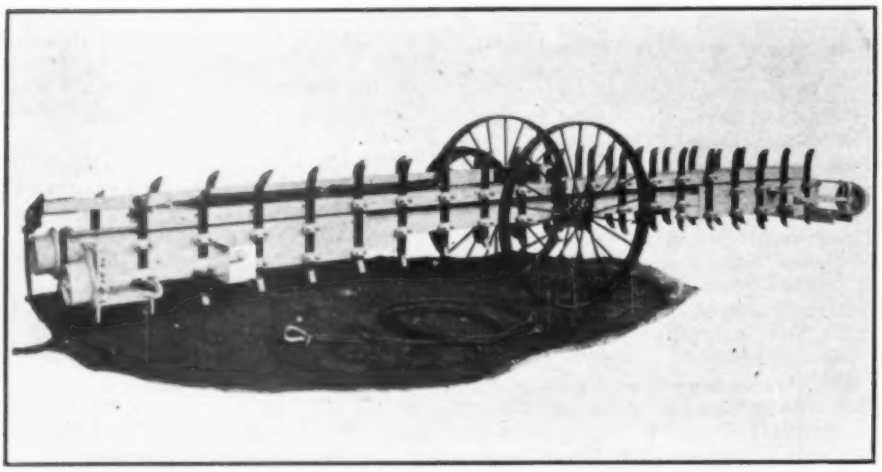
Having successfully passed a trying period of rigid tests and demonstrations, the manufacturer is now offering the Law Creeper Truck to the market. It can be equipped with stock bodies of the roll-over, gravity or power hoist types, in capacities of three cubic yards. It can be used either as a straight hauling unit, or as a combination hauling unit and tractor. Among its various uses are land development, road building, municipal work, general farming, irrigation work, mining and lumbering, sand, gravel and clay pits.

Chicago Firm Producers New Subgrade Machine

Ted Carr and Company, 939 North Ave., Chicago, announce placing on the market a new subgrade machine called a True Grade Scarifier. It is adapted to run on the forms and scarify the subgrade to an exact depth for highway construction. It is intended to cut high places off of the hardest subgrades, and is built so heavy and compact that before any one scarifier tooth could raise up it would have to lift half of the weight of this two ton machine.

The frame is adjustable to different widths of road from 16 to 24 ft., and carries 47 double-end plow steel scarifier teeth, so arranged that there is ample room for earth to pass between them, while at the same time they come in a new path on the return trip so that they have scarified the ground every three inches. Wheels with powerful lift springs are provided at the center to enable the operator to raise it up and turn it around or run it off to one side.

For a long time the Engineers have required a Scratch Template run on the forms which merely marks the high places. This is intended as a Contractors Scratch Template that will scratch the high places off.

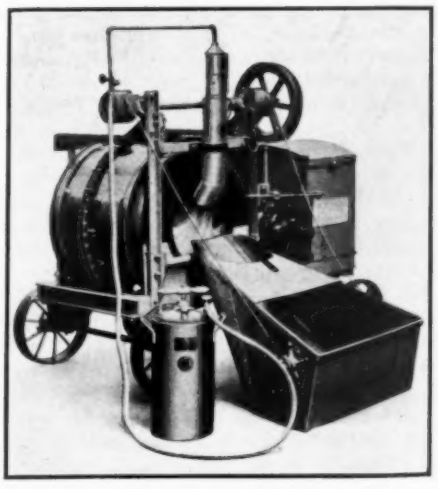


The New Grade Scarifier for Use as a Scratch Template. Recently Developed by Ted Carr and Co.

Concrete Heaters for Cold Weather

A line of kerosene burning concrete heaters suitable for mounting on any make or size of mixer are now being offered to the trade by Littleford Bros. of Cincinnati, O. The line includes units for application on either tilting drum mixers or non-tilters. One of these units mounted on a Knickerbocker non-tilting mixer is shown on the accompanying illustration.

With such a heater installed on a mixer, the manufacturers claim a mix can be discharged in zero weather at a temperature of 75° F. No additional labor is required as the man who operates the mixer also operates the heater.



A Heater of this Type is Said to be of Real Help on a Cold Weather Concrete Job

The unit consists of a torch type oil burner of proper size, depending on capacity of mixing drum, with fuel tank, oil hose, necessary fittings, elbow flame deflector, and band for attaching to mixer. Installation is a very simple matter.

A simple valve adjustment regulates flame to any desired size. Windshield on burner assures perfect operation under all weather conditions.

Opening of Concrete Pavements to Traffic

The Beam Test as a Guide to Determine When Pavement Is Ready

By EDWARD E. BAUER
Instructor in Civil Engineering, University of Illinois

The transverse bending or beam test is being used more and more to determine the strength of concrete used in concrete pavements. Frequently sample beams are cast while the slab is being poured. The beams are then cured in the same manner as the slab and tested at various ages to determine when the pavement is ready to open to traffic.

What strength should the concrete have before it is ready to be used? This depends upon several factors: (1) the thickness of the slab, (2) the maximum load that is to come on the slab, and (3) whether provision has been made to transfer part of the load across the transverse joints and cracks.

Table I has been prepared based on Older's theory of pavement slab design. This theory may be stated briefly as follows: The pavement slab should be designed for its weakest portion, which occurs at the intersection of a transverse joint or crack and the edge of the slab or a longitudinal crack or joint. Tests indicate that frequently these corners are off the subgrade so that the slab acts as a cantilever beam. This cantilever beam then can easily be analyzed. The stress at the extreme fibre (the transverse bending stress) is given by the formula

$$S = \frac{3P}{t^2} \quad \ldots\ldots (1)$$

in which:

P equals the load in pounds applied at the corner.

t equals the thickness of the slab in inches.

If steel is included so that half of any load is transferred across any joint or crack, the formula becomes

$$S = \frac{3P}{2t^2} \quad \ldots\ldots (2)$$

In the table values of transverse bending stress are given for thicknesses of slab varying from 5 to 12 in. and for wheel loads of 6,000, 8,000, 10,000 and 12,000 lb., for both free and dowelled corners. No allowance has been made for impact. The stress varies directly as the load and inversely as the square of the thickness. For a given design the stress will increase or decrease as the loads increase or decrease, the stress for a 12,000 lb. wheel load being just twice that of a 6,000 lb. wheel load. For given wheel loads the stresses vary as the square of the thickness, the stress for a 12 in. slab being only one-fourth that of a 6 in. slab. Transferring half the load across a joint or crack is just like cutting the load in two.

Values in excess of 900 lb. are rare at 28 days and should not be counted upon unless test results show values that high. 600 to 700 lb. are average results for the usual 1:2:3 or 1:2:3½ mixes at 28 days. A number of factors affect the rate at which concrete gains strength, such as temperature, richness of mix, quality of cement, and curing methods. Testing is after all the only safe method to determine when a concrete pavement is ready to open and then the design and possible wheel loads must be taken into consideration.

Table I—Values of Transverse Bending Stress (extreme fibre stress) for Various Values of Thickness of Pavement Slab and Load for Both Free and Dowelled Corners

(Computations based on Older's formula)

Thickness of slab inches	Free Corner: None of load transferred across transverse cracks or joints. Wheel loads in pounds			
	6,000	8,000	10,000	12,000
5	720	960	1,200	1,440
6	500	665	835	1,000
7	370	490	610	735
8	280	375	470	565
9	220	295	370	445
10	180	240	300	360
12	125	165	210	250

Thickness of slab inches	Dowelled Corner: Half of load transferred across transverse cracks or joints. Wheel loads in pounds			
	6,000	8,000	10,000	12,000
5	360	480	600	720
6	250	335	420	500
7	185	245	305	370
8	140	190	235	285
9	110	150	185	225
10	90	120	150	180
12	65	85	105	125

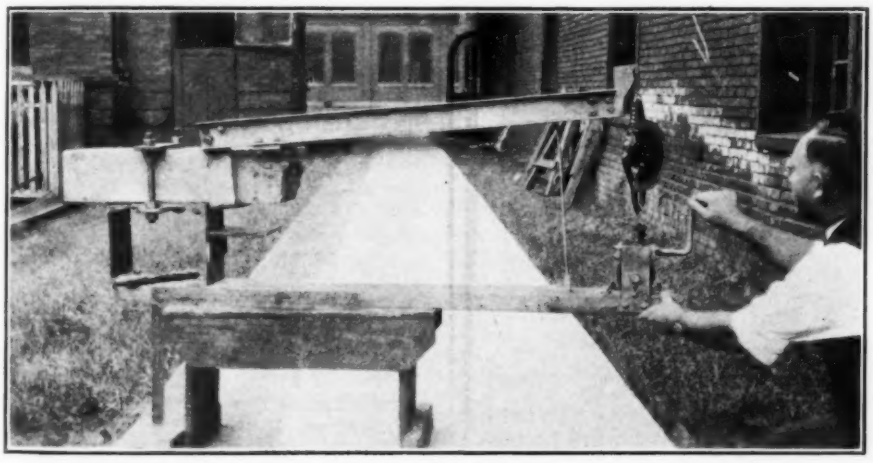


Fig.1.—Apparatus Used at the University of Illinois for Making Beam Test

Comparative Tests on Concrete Cylinders of Different Sizes

From November Technical News Bulletin of U. S. Bureau of Standards.

A series of 216 concrete cylinders, mixed and made in the field, half of which were 8 by 16 in. and the remainder 10 by 20 in., were recently tested at the bureau. The object of the series was the determination of the comparative strengths developed by the two sizes of specimens, using local sand and gravel under field laboratory conditions.

The cylinders were made in a small field laboratory, the concrete being mixed in a small batch mixer. Each batch was large enough to make four 8 by 16 and four 10 by 20 in. cylinders. After mixing to the desired consistency, the batch was emptied into a wheelbarrow and a shovel-full was placed into each of the paper cylinder molds in succession until filled. Each cylinder was properly tamped during filling.

Three mixes were used, 1:1:2, 1:1½:3, and 1:2:4. The 1:1½:3 and 1:2:4 were tested at 3, 7, and 28 days. The 1:1:2 mix was tested at 3 and 28 days. For each proportion the concrete was mixed to three consistencies giving the approximate slumps of 2, 4½, and 6½. Since the cylinders in each group have the same amount of cement, water, aggregate, and mixing time the strength ratio of the 10 by 20 and 8 by 16 should be unaffected by many of the variables which enter cylinder making when duplications of mixes are attempted.

The average strength of the 10 by 20 in. cylinders was 96 per cent of the average strength of the 8 by 16 in. cylinders. The strength ratios were 92, 98, and 96 per cent, respectively, for the 1:1:2, 1:1½:3, and 1:2:4, respectively.

In connection with the testing of cylinders of several sizes, it is important to note that if tested in one machine at the same platten speed the increase in strain will be slower for the small specimens, a phenomenon observed and noted in the test of mine stoppings[1] and by Prof. D. A. Abrams.[2] The strength ratios were opposite to what might be expected because of this effect.

[1]Technical News Bulletin No. 118.
[2]Eng. and Cem. World, Jan. 15, 1918.

Highway Contracting in Washington

Some of the Problems Outlined in Paper Presented at Last Annual Convention of Pacific Northwest Branch Associated General Contractors of America

By J. W. HOOVER
State Highway Engineer, Olympia, Wash.

The state highway department of Washington has a large program for 1927 and 1928, and the state law prescribes just how contracts for state highways shall be advertised and the awards made. The advertisements appear in the official paper of the county in which the work is located and several other publications of general circulation. The law requires that the bidder shall deposit with his bid a certified check equal to 5 per cent of the amount of the bid, and the bidder to whom the contract is awarded shall within ten days furnish a bond equal to the full amount of his bid.

Irregular Bids.—It is the policy of the highway committee to award the contract to the lowest bidder whose tender is regular. That is to say, irregular bids will not be considered. A bad bid is considered irregular if an item is omitted, if the certified check is below the required amount or if the bidder fails to enclose such a check, and if conditions are written into the bid. At times it seems that the most careless people in the world are bidding on contracts. One will omit a bid opposite an item of work; another will forget his certified check; another will have a check but it will be less than the required amount. And then the next fellow is over cautious and writes a clause or two to keep himself in the clear. All such bids will not be considered.

We have heard a lot about the irresponsible bidder in the past few years. This term or description does not refer so much to the bidder who seeks a contract, although he is absolutely unqualified in one or more of the essentials for the class of work which is sought. They are not perennials; they never come back for a second contract; but they seem to be like the poor, they are always with us.

Irresponsible Bidders.—Irresponsible bidders are those who are novices, who have had no experience; those who have insufficient funds or equipment for the particular class and volume of work sought; those who are plungers; gamblers who size up the field of bidders and their previous bids on other work, and then make up a bid without knowing or figuring costs. Irresponsible bidders can well be classed as gamblers, bidding against this or that man or firm, instead of the actual costs of the work plus a fair profit.

It is hardly fair to criticize a contractor unduly for sizing up bidders; to do so is natural. But we do criticize those who think that they can do any class of work as cheap or cheaper than the other fellow. Some people can do a good many things well and some people can not; however, as a general rule there is some one line that a particular person can do better than the other fellow. Each of you, perhaps, has a particular line of work that you can do exceptionally well. But don't think that you can do all or many lines of work better than the other fellows, for we know that some firms do paving work unusually well, others handle team work or shovel work for less than their competitors and others build bridges for less money than do other contractors. We know that this is true and we know that the bidder who figures he can do a kind of work as cheap as the other fellow and bids on the other fellow's cost and not his own is headed for trouble. I repeat: there are contractors who can do a particular kind of highway construction cheaper than the balance of contractors in the same line of business. Therefore, I recommend that you bid on your own costs—and study the other fellow's methods.

The Novice and the Plunger.—To get back to the other irresponsibles—the novice and the plunger; these classes of bidders make up the bulk of contract failures. The loss is not alone their loss, but generally their incompetence causes losses to those who deal with them and to the public through less use of the highway, the cost of upkeep on the detours made necessary by reason of defaulted and slow work, the loss of time to the traffic, and many other items, including increased costs of engineering.

Sometimes contracts are awarded to a low inexperienced bidder when the second low bidder is but a few dollars higher, with the result that the work is long delayed and the contractor fails, whereas the second low bidder could have completed the work on time and at a profit. What is the cure for irresponsible bidding? The other bidders, the materialmen, the bankers, the bondsmen all put it up to the public official, saying that he should reject the bid. This might be done; but why should a public official refuse to award the contract and take abuse of a political nature on the one hand and from dissatisfied persons shouting graft on the other? Even to reject the irresponsible bid would not eliminate the plunger. We have seen old, well established firms taking severe losses and sometimes failing; often they take an unnecessary and unreasonable length of time to complete their work. Bidding against the other fellow's costs or bidding without knowing and figuring costs has brought losses and sometimes failure to firms that had been engaged in contracting business for years.

Illinois System of Determining Bidders' Qualifications.—The state of Illinois has worked out a system by means of which they determine what they believe to be the qualifications of a bidder. If the bidder does not qualify for the job, his bid is rejected. The plan is reported to be working successfully. However, it seems to be that they have taken the place of the bonding company and the banker, either of whom could, and most certainly both should, examine the bidder's financial conditions and qualifications very carefully. I can see no reason why the bonding companies and the bankers cannot adopt a similar system and apply it to their business, thus assuring profit and the interests of their clients. I know of cases where the banker and the bonding company have extended credit and written bonds for bidders who had no qualification other than the nerve to bid and ask for service. And then all of them complain when they lose their money. It is a marvel how some bonding companies and bankers continue if that is the careless way in which their business is conducted.

The highway committee, on several occasions has taken under advisement bids that appeared to be of the irresponsible character with the result that the political friends of the bidder, senators and representatives and others, importuned the members of the state highway committee for days to make the award to the bidder. In view of the endless trouble that this plan would make for the state highway committee and for other reasons, I doubt if the Illinois plan could be made successful. The question is up to the bankers and the bonding companies for solution and it can be readily solved by them with a material reduction in their own losses and a reduction in contractor's losses and failures.

Contract Time Limit.—I wish also to stress the necessity for completing contracts by the time specified. It is true that at times the climatic conditions or other factors are such that the work cannot reasonably be completed in the time given. Occasionally there is a job that must be rushed and the time limit is fixed accordingly. The two clearing jobs on the Sunset Highway on either side of Snoqualmie Base, are recent examples. It is very important that these contracts be completed by early summer, as we have plans for a large amount of work on the Sunset Highway and the clearing and burning cannot be done during the fire season. If this part of the work is not out of the way by summer, almost all of the 1927 season for grading will be lost and the opening of the new road to traffic will be delayed for a year.

You must figure, therefore, that if the time limit specified requires rushing the work—that is what is wanted. Your bid should take the increased cost

into consideration and your plans should be made to complete the work on time. The department will be more strict in enforcing the time limit than in the past. We expect to check up on the contracts from time to time and will insist on sufficient labor and equipment to complete the work as required.

Section four of the contract provides that if the contractor does not supply sufficient labor and equipment to complete the work as specified, the state highway engineer may on three days' written notice to the contractor and his surety, transfer the contract to the bonding company, or the state may complete the work at the contractor's and bonding company's expense.

In bidding on state highway work you may expect that we will insist on vigorous prosecution of the work and completion on time. The reason for our insistence on this point should be apparent to all. The work is planned to give the road over to traffic at a certain time for reasons generally involving detours and great inconvenience to the traffic. Detours are expensive not only to this department but also to the traveling public, and we are not going to stand by and permit abuse of the public because some contractor does not want to push his work.

The highway department has been following, and contemplates continuing to follow, the policy of doing all work by contract which is capable of being handled that way. During the past two years, however, the department has been in receipt of considerable adverse criticisms because of the non-completion of a number of small contracts which were not completed in anywhere near the time they should have been. If the highway department is to continue doing these small jobs by contract it will be up to the contractors to get them done on time.

In conclusion, I wish to say that the state of Washington considers the contractors a part of its highway organization necessary to the successful performance of its highway program. I have made these remarks in the spirit of acquainting one branch of our highway organization, namely, the contractors, with the viewpoint of another branch, namely, the engineers, so that both may have a successful year.

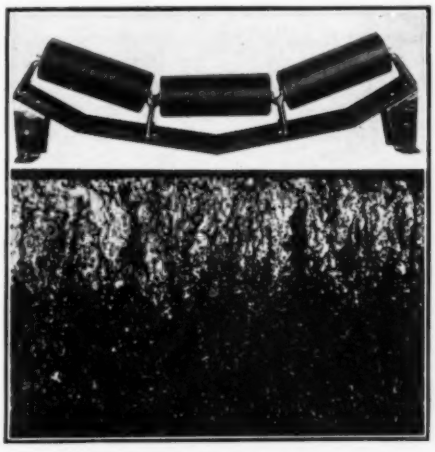
Financial Condition of Texas Highway Dept.

The Highway Department had a balance of only $687,108 at the end of the fiscal year 1926 as compared with a balance of $6,362,859 at the beginning of the present fiscal year Sept. 1, according to W. Gregory Hatcher, State Treasurer. Outstanding warrants against the department total $721,801.

During the fiscal year beginning Sept. 1, 1926, the department received a total of $25,593,773 and disbursements were $19,918,021.

Chilled Cast Iron Pulley on Stearns Idler

The Stearns Conveyor Co., of Cleveland has put out a new anti-friction cast iron pulley whose outer surface is made of chilled iron. This surface is said to be extremely hard and able to stand the most severe wear under a wide range of conditions from extreme heat to cold. Chilled Iron is the metal commonly used in plowshares, railroad car wheels, traction wheels and so forth. It has always been difficult to put a good chilled iron surface on a small casting, particularly a shell, but



Top—Three Pulley Cast Iron Carrier With Chilled Pulley Shells
Bottom—Section Showing Depth of Chill in the Shell Casting

the Company now manufactures an idler pulley having a good depth of chill. The illustration shows the evenness and depth of the chill in the new Rex-Stearns idler pulley. It is said to have a denser and tougher material than a common chill, capable of receiving a very high polish and to contain the most wear resisting material that is commercially practicable today.

Within, the metal grades evenly to grey iron, giving the pulley a hard, smooth, wear-resisting surface with a relatively tough inside, according to the manufacturer. The one-piece closed end design makes these pulleys practically unbreakable even under the severest service, it is claimed.

A Combination grease seal keeps dirt out of the bearings, and keeps the grease in, making lubrication and attention necessary only at long intervals.

The Stearns Conveyor Company is owned by the Chain Belt Company in whose foundries the new idlers are being cast.

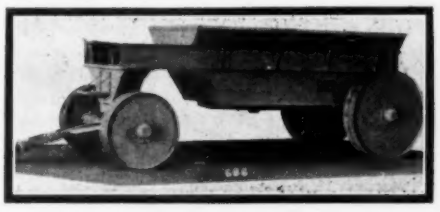
New Mexico Adopts New Ditch Section

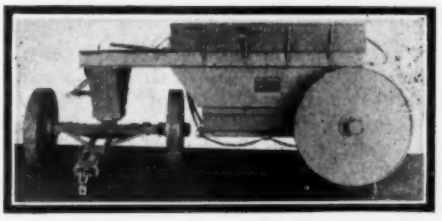
Advantage is being taken in New Mexico of a type of road construction said to have been originated in Oklahoma by Cyrus S. Avery, national figure in highway circles, and termed by him as the "Drive In and Drive Out Highway," according to a highway department bulletin released recently.

"There are many miles of mesa and prairie located highway in the state," says the bulletin, "upon which it will be impossible to build federal aid type of highway for many years. Upon these the state has built and is constantly rebuilding a grader type of construction known as the 'mesa type.' To make these mesa roads safe for motorists the deep ditches are being filled up and a wide, shallow ditch substituted—a 'Drive In and Drive Out' ditch. That is, a ditch such that if a motorist is forced into it or accidentally drives into it, he will not be precipitated over the landscape with his car, but can, with ordinary quick handling of his car, pull over the ditch and out onto the mesa or, more often, guide his car back into the road again without mishap.

"This type is being built in the regrading operations between Santa Fe and Albuquerque, and elsewhere with excellent results. As rapidly as these mesa state roads are regraded the 'Drive In and Drive Out' method of construction will replace the old deeper ditch type."

New Tractor Wagon Announced





The above cuts show two models of tractor wagons introduced this year by the Rex-Watson Corporation, of Canastota, New York. These vehicles are said to have a number of interesting features.

$500,000 Bond Issue in Iowa

The voters of Van Buren County, Iowa, have voted a $500,000 bond issue for highway construction, according to a recent news item. This fund will finance paving under state supervision on Highway No. 1, crossing the county north and south, and Highway No. 3, traversing the county east and west.

Problems of the Highway Contractor

Viewpoint of Canadian Contractor Given in Paper Presented 14th Annual Convention of Canadian Good Roads Association

By H. T. ROUTLY
Of the Routly Construction Co., Toronto, Ont.

I want to draw your attention to certain problems. These are basic problems, and though I may fail to present them in the clear and convincing manner their importance merits, I shall be satisfied if your minds are opened to some of them and set working for a solution. They are some of the problems which involve the interrelations of the principal, the engineer and the contractor. By "The Principal" in highway work we mean those representatives chosen or elected by the public, from the federal minister who deals on the side with highway matters down to the chairman of the township roads committees, and by "Engineer" we mean those officials employed first to give expert technical advice and later to supervise the actual construction of our highways.

The Necessity of Justifying Public Confidence.—And the first problem for all is the basic necessity of justifying public confidence in our highway programs. One of the main elements on which this confidence is founded must be that its monies are expended in the most efficient and economical manner. And the ideal of greatest economy and maximum results is possible only where each of the three, the principal, the engineer and the contractor, is thoroughly qualified to contribute his quota, and where a proper spirit of harmony and co-operation exists between them. The economy and the quality falls and the cost increases when any one of the three is incompetent, or when any one of them throws the monkey wrench of discord into the combination. The failure or refusal to co-operate or to justify co-operation is unpatriotic and disloyal, and results ultimately in placing an unnecessary burden on the tax-paying public—though it generally comes first of all on the contractor involved and constitutes one of his most serious problems.

Relations of Principal and Contractor.—Now in what manner does the principal form one of these problems of the contractor? It is the duty of principals to study the needs of their constituents and it is their responsibility to prepare the program. One of the ways in which the principal often fails to contribute his quota towards ultimate economy, and one of the ways in which he becomes a real problem to the contractor is in his failure to outline a comprehensive program so that the contractor can gauge what may be expected from him and his associates during a period of years. Also in the time and manner in which the principal brings on his work may much be lost or gained in the final cost.

A serious problem has arisen for many a contractor in the past when the principal has awarded contracts away in excess of the funds provided. Now that our various provincial and county departments have had time to organize and to choose the roads for which they are assuming responsibility, a lot of money could be saved by the adoption of better methods of letting their work.

If each season's program could be outlined the previous summer and most of the contracts awarded in the autumn, contractors could bid lower, use winter months to advantage, organize better, execute quicker, cause less annoyance to the travelling public and make more consistent profits.

This is one problem of the contractor which the principal alone can solve but from the nature of our governing institutions he is often unable to put his solutions into practice. In so far, however, as the principal can systematize his program by early announcement of his future work, and by autumn lettings in contracts of sufficient magnitude to permit the installation of the most economical plant, and by stabilizing his annual program so that competent contractors are reasonably sure of employment from year to year—in these and many other ways may the principal help to solve the great problem of uncertainty for the contractor to the ultimate benefit of the public he represents.

Position of the Engineer.—Now the biggest of all the contractor's problems is the engineer. And conversely the biggest problem of the engineer is perhaps the contractor. Some members in each class fail to recognize that they too are jointly and severally responsible to the principal and the public he represents for a careful, economical and proper expenditure of the money provided. They are essentially co-workers, almost partners, and only when they work in a spirit of harmony and mutual helpfulness can the desired end be obtained at the least expense of time and money. If either adopts a spirit of discord, or seeks to hamper, embarrass of interfere with the other, he is untrue to the best ethics of his profession and disloyal to the interests of his principal. And with the best intentions, no doubt, but from a wrong mental attitude, the engineer is frequently responsible when friction exists.

To begin with he often initiates a lot of avoidable trouble; (1) by unreliable or ambiguous data or lack of essential data in his information to bidders; (2) by the one-sided nature of the contract, for which he is not always to blame; (3) by the unduly exacting clauses in his specifications; (4) by his assumption of superior wisdom and absolute authority, while completely shirking responsibility for results; (5) by his attitude of mind whereby he treats the contractor from the beginning as a crook and a cheat and ends by practically forcing him to become one to save himself alive.

I am pleased to note in the Province of Ontario a decided tendency to be more clear and specific in the preliminary information, more courageous in accepting responsibility and more fair and businesslike generally in dealing with contractors and construction problems. There are still possibilities for improvement and I should like to see the institution of an annual conference where all these matters could be fully discussed and debated by the negineers and the contractors in the presence of the principal or his deputy.

This recommedation is not limited to the Province of Ontario alone, but is suggested for the consideration of other Provincial, County and Suburban Road Systems. Joint conference would do much to remove many class as well as individual, misunderstandings.

The recently formed Ontario Road Builders Association invited to its first annual dinner a representative list of principals and engineers. The Associated Building Contractors of Ontario recently entertained their engineers, the Ontario Association of Architects. These events show the present-day tendency towards co-operation and better understanding and both are down for annual repetition. In their frank acceptance of these invitations the engineers and architects not only demonstrated their willingness to associate on friendly terms with contractors, but indicated also their belief that public sentiment now approves what might at one time have been considered ill-advised. As the contracting and engineering professions each come to a better understanding of the other's difficulties, the other's aims and the other's qualifications, and come more and more to realize that the best results are gained by co-operation rather than by coertion, the benefiting public will readily endorse the higher estimate each places on the other and readily approve the removal of the age-old barricade of mutual distrust.

The Contractor Vitally Concerned in Delivering a Satisfactory Job.—Before leaving the subject I want to make two or three statements all of which I hold to be true and which I earnestly recommend to the self-examing thought of those engineers and inspectors who still hold to the ancient theory that the contractor is a public enemy and a rogue who deserves to be continually brow-beaten and bulldozed on general principals. If that particular type of engineer could absorb these truths, they would revolutionize his viewpoint and result in faster and better con-

struction and in lower prices for future work under his supervision.

1. The most capable engineer cannot secure a first-class job from an incompetent contractor.

2. A competent contractor can often do a good job in spite of a poor engineer, but he can do a better job a lot easier for a good engineer.

3. Of all those associated in the execution of a highway contract the contractor is the most vitally concerned in delivering a satisfactory job. Prompt settlements and repeat orders are essential to his continuance in business. He has his family inheritance and past profits, his present hopes and his future prospects all at stake.

The Incompetent Contractor.—And finally the problem of paramount importance probably is: "To be or not to be a highway contractor," and this involves the problem of the incompetent contractor. Fully 80 per cent make the mistake of their lives when they attempt to solve this problem. And I am not joking when I say it. It is no joke but an economic tragedy that scores, aye hundreds, of men plunge into an occupation for which they are unqualified by nature and experience to make a sucess; and in making the fatal error they drag their families and dependents through years of hardships and disappointment, only to end in disaster. And while the unfortunate contractor has been making a mess of his own affairs and has caused grievous loss to those legitimately in the business, he has very often been making a bungle of the public contracts he has undertaken.

It is not claimed that all the men who tried to make a sucess of highway contracting and failed have made a bungle of the work they left behind, or that the public did not receive more than it paid for in some cases. Far from it. Many a man has put the last dollar and the last shred of nerve and energy into fighting vainly to fulfill his contract, a practical impossibility well recognized from the first by his more experienced competitors; an impossible situation which the principal, as representing the people, and the engineer as his expert adviser, should have also recognized and taken effective measures to forestall. Not simply to save the benighted individual and his family and his creditors from the dire results of his own lack of judgment. That alone would justify our highway authorities in taking some measures toward the prevention of so much wreckage.

Our officials are not permitted to condone or encourage personal suicide, neither should they be excused if they deliberately encourage or permit a man to commit financial suicide, often involving disastrous consequences to many even outside his own family circle. Some definite attempt should be made to prevent these obvious and useless disasters. The spirit of organized Canada resents being exploited for private gain. But on the other hand it detests the kind of profit which costs one of its members his substance, his home, or his health. All it desires is workmanlike service on fair terms.

In professional life only certified men and women are permitted to furnish the public its law, medicine, education, nursing, dentistry, or theology. None but certified men may do its electrical work or its plumbing. Certificates of qualifications are required to provide milk, meat, drink, and entertainment. The surveyors and engineers who design and supervise highway and other construction must pass exacting tests and secure certificates of qualification. Even the truck drivers and engine runners on highway contracts must bear certificates of competence. But the one individual on whom more than on anyone else depends the economy and the safety of the structure generally requires one lone qualification—that he be low bidder.

The problem of the incompetent contractor of course far transcends the mere question of low bidder, though that is the usual mode of entry. I can offer no complete solution for this problem, but would venture to suggest that all public contractors should have to pass a strict investigation of their experience, business character, financial standing and other qualifications by some properly constituted board, who would issue certificates of the amount and class of work each applicant was deemed competent to undertake, and without which no tender might legally be received by any public officer. Surely with all the other advances in highway matters it is high time that some real effort be made towards solving the problem of the incompetent contractor. It cannot be expected that the present authorities or even such a board could exercise infallible discretion and make no errors, but that is a poor excuse for doing nothing.

Creosoted Timber Causeway Solves Difficult Highway Problem

Considerable difficulty was experienced by C. B. Taylor, Bridge Maintenance Engineer of the State Highway Commission of North Carolina, in the upkeep of a section of highway on Route 90, near Columbia. At this point Route 90 crosses Piney Marsh, and for a distance of about 4,500 ft. the natural conditions of the soil are very unfavorable for highway construction. One foot of substantial top-soil is underlaid with 60 ft. of wet, sticky mud of poor supporting power, with the result that a solid foundation for a roadway was difficult to obtain. How this problem was solved is described in the July issue of Wood Preserving News.

Untreated piling, two to the bent, driven on 17 ft. centers and from 40 ft. to 90 ft. in length, was first driven to a depth well below the unstable mud strata, so that each pile was securely embedded in the underlying firm earth. These piles were then cut off below the permanent line of saturation and the upper 2 ft. encased in a cement jacket extending 8 in. above the cut-off. Then the foundations were capped with creosoted timbers, 12 in. by 12 in. by 18 ft., securely held in place with ⅝-in.-by-18-in. drift bolts.

Creosoted stringers, 4 in. by 14 in. by 18 ft., were placed on the caps, and creosoted flooring, 3 in. by 4 in. by 18 ft., was laid. The flooring was held securely in place by being toenailed to the stringers and horizontally nailed to each adjoining piece. A creosoted timber felloe guard was provided along each side of the causeway, consisting of a 6-in.-by-8-in. timber laid on scupper blocks, 4 in. by 6 in. by 1 ft., which were placed on a 1½-in.-by-12-in.-by-18-ft. retaining strip directly on the floor of the structure, all of which was bolted through to the floor with lag screws on 4 ft. 6 in. centers. A wearing surface of natural rock asphalt was then laid on the sub-flooring.

The finished product is a wide, smooth causeway 4,241 ft. in length, consisting of 247 spans, 19 spans being on a curve and the remainder on the tangents on each end of the curve.

All timber used in this structure, with the exception of the piling in general, is southern pine treated under pressure with coal-tar creosote with a minimum retention of 18 lb. of preservative per cu. ft. for joists and caps, and 12 lb. of creosote per cu. ft. for other treated timber. Piling between bents Nos. 236 and 248 inclusive was treated with 18 lb. of creosote per cu. ft.

New Book

Highway Engineer's Handbook, by Wilson G. Harger, C. E., and Edmund A. Bonney; Fourth Edition, 1,721 pages and index, 4 by 6¾ in., leather; McGraw-Hill Book Company, Inc., 370 Seventh Ave., New York City; price $6.00.

This new and revised fourth edition is better and more comprehensive than previous editions. In fifteen years this worthwhile handbook has grown to over 1,700 pages from the 493 pages of the first edition. It is replete with methods, theory, hints, short-cuts, cost data, and other useful information, and affords inside one cover a worthwhile condensed library on highway matters. It is quite up to the minute, and very little appears to have been omitted. This book should prove well worth its price to the highway engineer who desires to avail himself of the experience of others. We cannot help but recommend it to our readers.

Blue Diamond Co. Uses Heil Hoists on Mixers

Ready mixed concrete, supplied to the job in accordance with the purchaser's specifications, is making a dent in the Los Angeles construction market. The service is based upon unique equipment. Instead of mixing the concrete at a central mixing plant and delivering by trucks, the Blue Diamond Co. maintains a fleet of trucks each equipped with an unusual type of concrete mixer. The aggregates and cement are loaded at the yard and water is placed in side tanks. The truck then proceeds toward its destination. On the way the batch is mixed, and when the job is reached the concrete is ready to put into the forms. Since the mixer must be discharged by dumping, and since this mixer is rather high, it was quite a problem to find a hoist that would handle the load and at the same time keep the center of gravity as low as possible.

In detail, the equipment consists of AXX Special Moreland trucks, carrying Barrymore concrete mixers mounted with Heil 4L-26 hoists. The mixers weigh about 4,800 lb., and are higher than ordinary bodies. An idea of the height saved may be gained from the statement that the mixer does not extend any higher than the truck cab and that only a ½ in. wood sill acts as a cushion.

The Blue Diamond Co. maintains a fleet of over fifty trucks, painted in distinctive colors and driven by uniform drivers. Their trade seems to be growing at a satisfactory rate, judging from statements that have been issued.

One of the Blue Diamond Company's Trucks with the Concrete Mixer

County Highway Officials to Meet at Cleveland, O.

It is expected that county highway officials, representing each of the 3,070 counties of the United States, will assemble in Cleveland on Jan. 9 for the first annual meeting of the national association of county highway officials. The meeting will be one of the most important ever held by those connected with the construction, maintenance and operation of county highways.

The meeting was called following the organization last June of a new County Highway Officials' Division of the American Road Builders' Association, of which Thomas J. Wasser, of Jersey City, N. J., is president.

The sessions will comprise the reports of various standards committees, the objectives of which are to draw up standards for county administration, finance, legislation, construction, maintenance and operation of county roads. The reports will consist of a summary of the best practices as now in force in the various counties of the United States, together with recommended standards.

The convention which will be held in Cleveland is the world's largest good roads convention, and in connection with it will be held a road machinery and equipment exposition of over 300 carloads of road building and maintenance equipment, covering more than four acres of floor space. In addition to the county officials, approximately 25,000 other persons directly connected with the highway industry will attend.

The annual business meeting of the county highway officials will be held on Thursday, Jan. 12, with President Wasser presiding. Reports of various committees will be given and general routine business transacted.

The convention and road show is expected to give new impetus to the construction of county roads on a new economical basis designed to eliminate waste of county funds and increase the efficiency of county roads. Every county official directly or indirectly connected with highway operation, construction or maintenance is urged to be present. Reduced fares have been granted by all railroads to those who attend.

A Contrast in Paving Policies

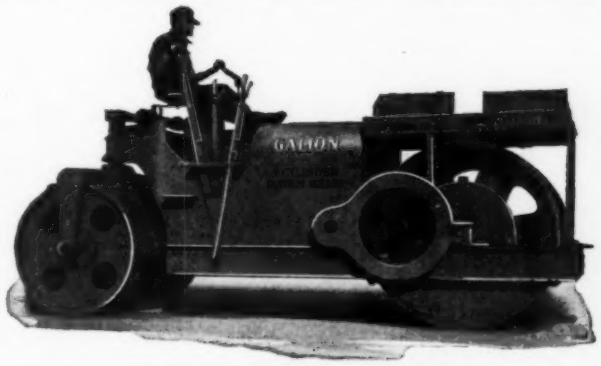
The topic of public works financing policies is important to everyone. It is interesting in this connection to note how two cities in the same state have fared with opposed plans. It is said that Toledo, O., adopting a pay-as-you-go plan with the acceptance of a 1 mill tax for street paving, is in a position to continue paving activities for at least four years. On the other hand, Cleveland has been proposing bond issue after bond issue, and upon the failure of a proposed $3,000,000 issue for streets and sewers must now curtail its paving program for 1928. It is said that the voters of Cleveland have grown tired of approving frequent bond issues.

A Fleet of the Mixer Trucks Operated by the Blue Diamond Company in Front of the Offices of the Firm

Galion Announces 10-Ton Tandem Roller

In line with their policy of meeting the needs of the road building and maintenance field as they arise, the Galion Iron Works & Mfg. Co., Galion O., has announced a 10-ton heavy duty tandem motor roller.

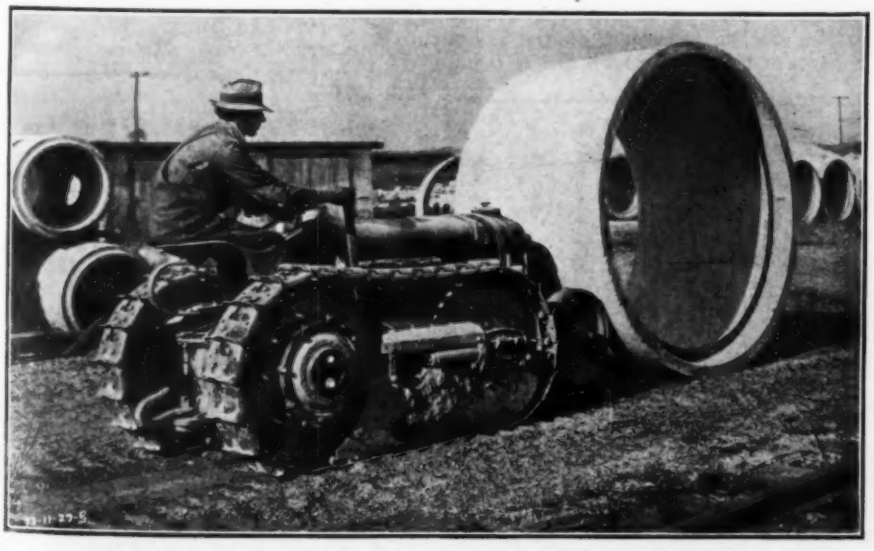
This new roller is powered by a Hercules Model G. motor. The power steering is operated by the same motor and a special transmission designed and produced in the Galion plant meets the special requirements of tandem service on asphalt. The important considerations in this work are, smooth operation always and quick, positive reversing, as jerky operation or allowing the roller to stand still more than an instant, will result in an uneven asphalt surface. Reversing instantly and smoothly without gear shift, the operation of this tandem is very quick and smooth. A test of several weeks on asphalt work under strictest requirements has shown that this tandem roller fully meets the requirements, it is claimed. In their new line of motor tandems in which the 10-ton heavy duty tandem is the latest, the Galion Iron Works & Mfg. Co., claims to have attained fully all the advantages of the steam tandem without the disadvantages of supplying fuel, frequent firing and the smoke annoyance. This roller completes the Galion line of motor tandems which now consists of 10, 9, 8, 7, 6 and 5 ton sizes. The Galion line also includes steam tandems in the same sizes.



The New Galion 10-Ton Tandem Roller

Tractor Used to Move Concrete Pipe

The Illinois-Wisconsin Concrete Pipe and Tile Co., of Beloit, Wis., according to Mr. M. D. Corcoran, superintendent, has used a tractor with success in handling large sewer pipe around the plant. This idea could as well be used on the job. Mr. Corcoran reports that their Belle City Crawler owned by his firm has done more for them as a time and labor saver than any piece of machinery on the place. Having a soft sand soil at the plant it was impossible to operate a wheel tractor so they decided on the crawler. This crawler operates on an average of nine hours a day and saves the labor of at least five men a day. It pulls four loaded flat cars, and when it comes to storing large reinforced concrete pipe it is the best sort of equipment that has been tried. An electric crane places pipe ranging in size from 24 in. to 72 in. and weighing from 1,000 lbs. to 7,500 lbs. and this crawler puts them in perfect rows through this soft sand a distance of 300 ft. as fast as the crane can bring them, Being able to turn in its own length it allows just twice as much room for storing purposes and the Fordson tractor it is installed on is always on the job when needed. A flexible roller, devised by the Belle City Manufacturing Co., is mounted on the front end of the tractor to make this work possible.



A Section of Large Pipe Being Pushed to Desired Position by the Tractor

Vermont Facing Heavy Cost for Reconstruction

The Vermont legislature met in special session recently to act upon the recommendation of Governor Weeks that it authorize issue of $8,500,000 in bonds for state highway and other flood-reconstruction purposes.

Among his detailed recommendations was a plan for the state to take over the entire burden of rebuilding all roads and bridges. Present laws limit bridge relief to towns to $5,000 for each new span, but with 1,218 bridges either destroyed or severely damaged the governor urged that enabling legislation be passed.

A complete survey of the damage to the highway system had shown the total estimated damage to be $7,750,000 for bridges and roads alone, while more than $500,000 more is needed to restore losses suffered by other state departments.

In that connection the executive's message urged that the contingent fund be increased by $100,000 and that $400,000 be made available for expenditures principally at the state hospital at Waterbury, the free library and the state library document room and printing plant, which suffered extensive damage.

Seattle to Pave 52 Miles of Streets

Under supervision of the city engineering department fifty-two miles of pavement will be laid on Seattle streets during 1928, according to present expectations. The work will cost approximately two and three-quarter million dollars and all of it is upon petition of property owners. Assistant City Engineer Walter Tiedeman emphasizes the fact that the work is petitioned for in the various districts which, he declares, indicates that Seattle citizens are making every effort to get out of the dust and mud, that they are desirous of improving the neighborhoods in which their homes are located.

The work projected up to a month or two ago by the city engineering department as forming the bulk of next year's paving program involves 47 miles of street surfacing. In addition, Engineer Tiedeman states, about five miles of new work will come before the city between now and the opening of spring paving improvement program.

Crane Makes Demonstration Tour

Sometime ago announcement was made of the Universal Crane motor truck crawler, an attachment for motor truck crane mountings, combining the speedy travel of a motor truck with the soft ground travelling ability of a crawler.

This attachment has created considerable interest on the part of state and county highway officials, cities and contractors etc., throughout the country, the manufacturers report. In order to permit them to see such a unit in operation as soon as possible it was decided by the Universal Crane Co. to send out a demonstration unit.

How the Universal Crane Motor Truck Crawler Treads Are Supported on Carrying Rack When Unit Is Traveling on Rubber Tires Over Paved Highways

The photograph shows the unit which left New York City, July 1, 1927, enroute on its own wheels to Cleveland, O.

All along the line of its travel, through Poughkeepsie, Albany, Syracuse, Rochester, Buffalo, Erie, Oil City, Pa., Pittsburgh, Warren, O., and Cleveland actual job demonstrations were arranged, showing how this unit is applied to different types of work. These demonstrations were worked out with interested local contractors, on actual jobs. These have included barge unloading, car unloading, basement excavating, trenching, erecting steel etc.

Further demonstrations were made to show the mobility of the unit over the roads on 8 rubber tired wheels and the ability of the unit, with treads in place, to traverse soft, rain soaked ground and mud, swamps, climb banks, logs etc.

Already this unit has travelled over 750 miles, under its own power on the 8 rubber tired wheels, over 100 miles of the travel has been made on the crawler treads, covering all ground necessary on crane, truck or crawler attachment.

The photograph shows the manner in which the Universal Crane Motor Truck Crawler treads are supported on a carrying rack when the unit is travelling on rubber over the paved highways.

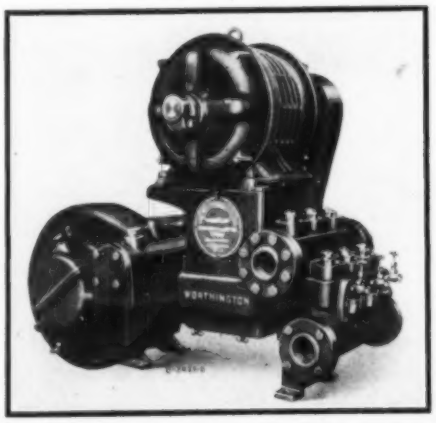
It is planned to send this demonstration unit through other parts of the country. The itinerary of the next trip is to be announced later.

Enclosed Self-Oiling Horizontal Triplex Power Pump

A new type of self-oiling triplex power pump, claimed to have special advantages, has just been placed upon the market by the Worthington Pump & Machinery Corporation. The mechanism, by reason of its cast iron case and cover, it is claimed, is practically impervious to dust, grit and other destructive particles of matter.

The pump requires but little maintenance attention. All moving parts are thoroughly lubricated from oil in the crank case so that the only work that devolves upon the pump operator is occasional draining and refilling of the crank case.

This new Worthington product is of the horizontal triplex, single-acting, outside packed plunger type and is being made in two sizes: 2¾ in. by 5 in., and 3¼ by 5 in. The pump will run at 200 r.p.m. crankshaft speed, which is stated to give the smaller pump a displacement of 77.5 gal. per min. against a pressure of 500 lb. per sq. in. The larger will displace 108 gal. per min., against a pressure of 360 lb. per sq. in. Reduction of speed will cause a corresponding reduction in capacity and horsepower requirements.



Worthington 2¾ in. by 5 in. Enclosed Self-Oiling Horizontal Triplex Power Pump Chain-Driven From Electric Motor

The gear ratio is 6 to 1, hence the pinion shaft may be direct-connected to a 1200 r.p.m. motor or engine without any additional gearing or belts.

The enclosed crankcase provides a very large oil reservoir for the flood lubricating system. The rim of the main gear runs submerged in the lubricant and carries oil to the top of the crankcase, whence it is distributed generously to all bearings. All moving parts run in a bath of oil, assuring smooth, quiet operation and long life, with minimum attention. All oil overflowing from the bearings is automatically returned to the crankcase and used over and over.

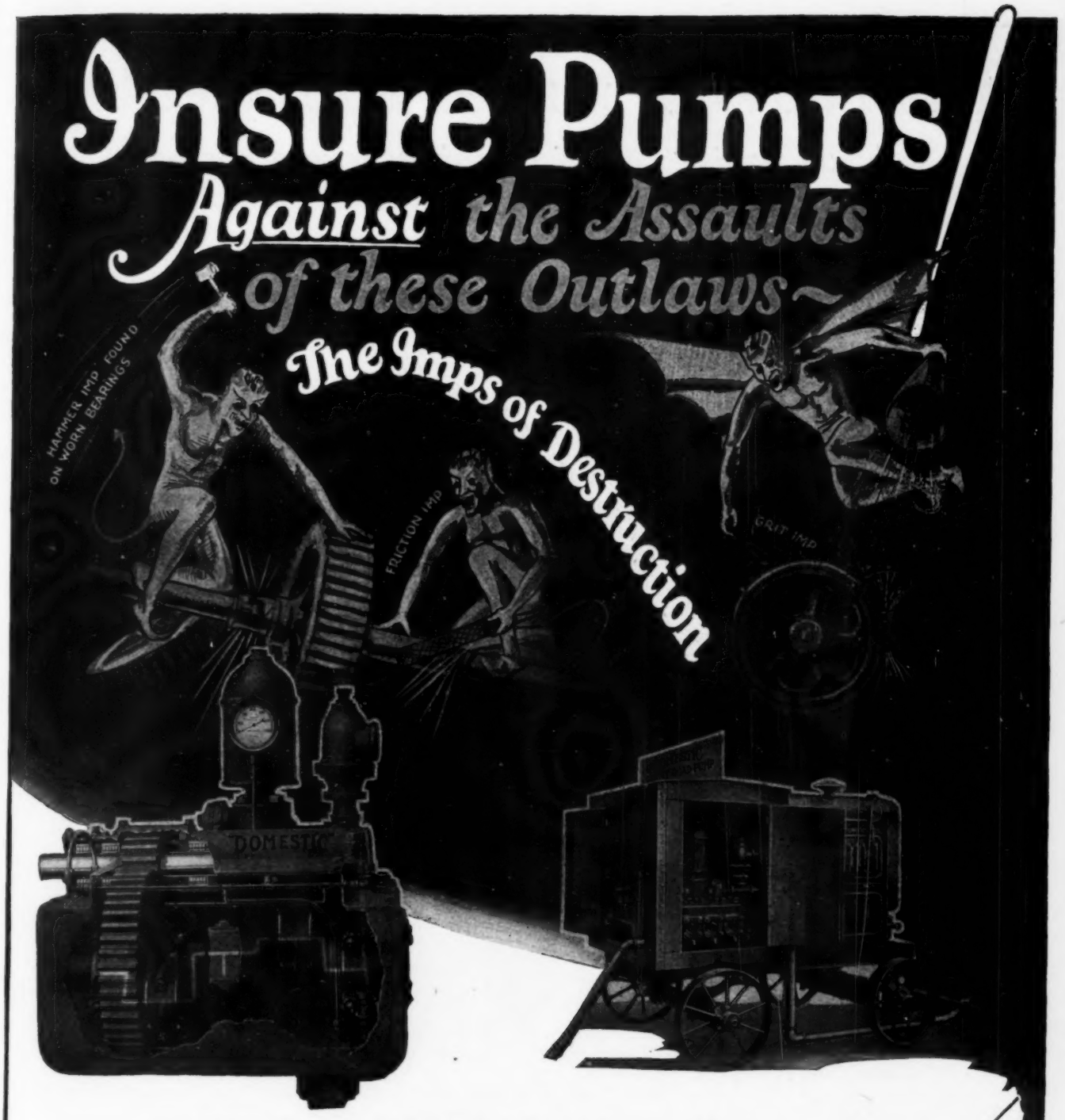
The fluid end of the pump is cast integral with the frame, with all valves separately accessible from above through individual handhole covers, making all moving parts easily accessible for inspection or replacement. The cylinder is of steeline, of the single-casting type. All fluid passages are of large area, short and direct. The valve chest is cast integral with the cylinder. Suction and discharge openings are cast with the chest, and are of the flange type.

The plungers which are cast integral with the crossheads are of grey iron, turned and ground and parallel through their length. The stuffing boxes are of grey iron, of the stud gland type especially deep, as required for high pressure, and easily accessible, yet protected from dust and grit by removable frame covers.

The valves are of the bronze-wing-guided type with heavy bronze seats driven into the deck on a taper. The valve guides are long, giving ample guiding surface and minimum wear. Bronze wire springs control the operation of the valves. Each valve is individually accessible from above through hand hole covers.

Traffic Control on Cuban Highways.—Cuba will shortly announce a complete system of traffic control, according to Dr. Coroalles, Chief Engineer of Roads and Bridges of the Public Works Department. His department has worked out a system similar to what he says is used in Europe in which various symbols are to be used instead of worded directions along highways for the warning and direction of traffic. Also the department is taking up the matter of bus traffic, which is very heavy, and will issue regulations regarding the maximum weights, etc.

Insure Pumps
Against the Assaults of these Outlaws~
The Imps of Destruction



"DOMESTIC" GIANT Triplex Plunger Pumps ARE INSURED against "The Imps"

SPECIAL FEATURES

DIRT PROOF AND OIL RETAINING pump and gear housings.
PRESSURE OILING SYSTEM. Oil supplied UNDER PRESSURE direct to every bearing.
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EXTRA HEAVY CRANK SHAFT drilled for oil passage to all its bearing surfaces.
GIANT ROAD PUMP UNITS are assembled with 35-HP. 4-cylinder industrial type gasoline engines, and for pumping capacities of 80, 100 and 150 gallons per minute against back pressure of 500, 375 and 225 pounds respectively.

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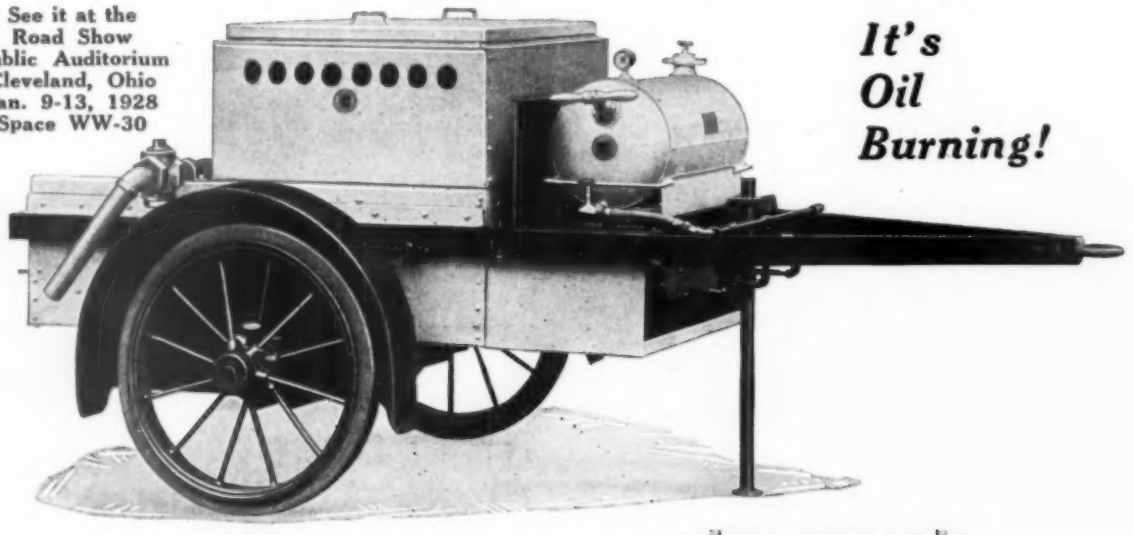
O No. 4

This NEW 3 burner Tool Heater

heats paving tools in 5 minutes and combines a melting tank of 50 gallon capacity

See it at the Road Show Public Auditorium Cleveland, Ohio Jan. 9-13, 1928 Space WW-30

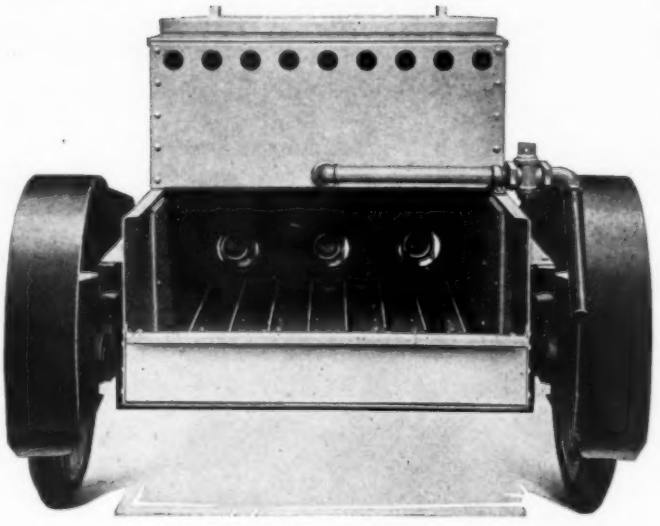


It's Oil Burning!

A Heater That Is Creating a Sensation!

The Littleford Oil Burning Tool Heater No. 90 is a combination tool heater and asphaltic cement kettle. It will heat paving tools in five minutes, and with its 50 gallon melting tank it eliminates the necessity for an extra melting kettle for ordinary repair work. It has a tool capacity sufficient to accommodate more than 15 paving tools. The asphalt cement tank, located above the heating compartment, has a capacity of 50 gallons and will produce hot materials within ten minutes after burners are started. Because of the absence of smoke, sparks or ashes, No. 90 can be operated in congested districts.

Write today for a copy of Bulletin C-5, which gives full and complete information concerning this newest of Littleford Heaters.



These 3 specially designed Littleford Burners can be operated independently or in combination.

Littleford Burners are safe, simple and troubleproof. A simple turn of the valves shoots the flame to a roaring blast or simmers it down to a white heat without shooting raw oil. The bottom of the heating compartment is insulated with Sil-O-Cel, which prevents heat loss. The rugged chassis, rigidly built, is mounted on steel wheels which are standard equipment. Rubber tired wheels are optional. Hubs are roller bearing. Springs absorb road shocks. Maintenance officials and contractors everywhere are praising the high efficiency of this the newest of Littleford Heaters.

City, state and county maintenance officials all over the country are maintaining their repair schedules right through the winter months. They are doing it with Littleford Oil Burning Tar and Asphalt Heaters and Littleford Portable Oil Burners. Their intense heat and all around convenience make repairs possible in cold weather. Write today for full information regarding Littleford Oil Burning Tar and Asphalt Heaters.

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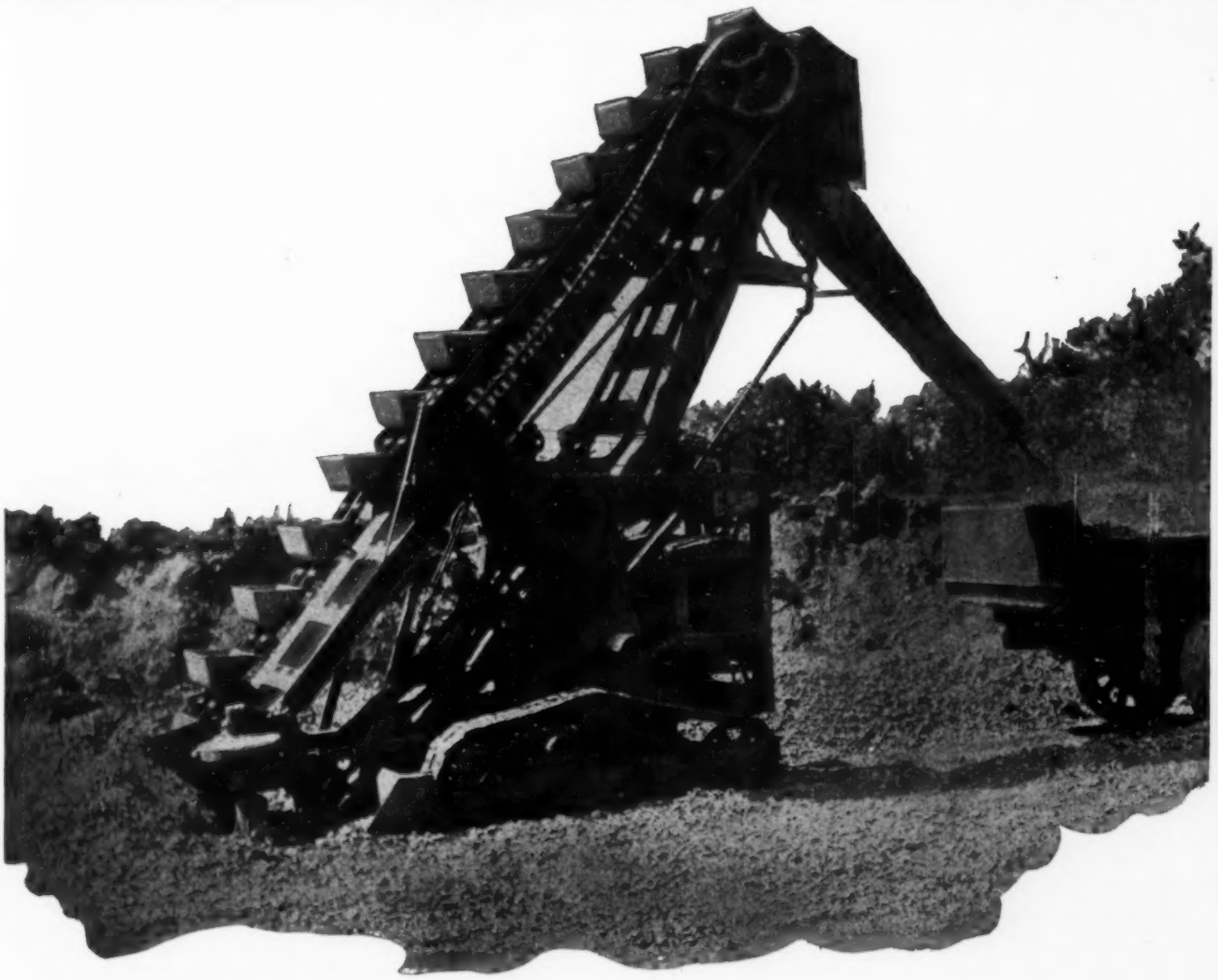

Skimming the Ground

There's No Shovel Clean-up

The B-G disc-feed can be set to skim the ground—missing the dirt at the bottom of the pile—and yet digging so neatly that no shovel clean-up is necessary. And it doesn't ask the buckets to dig for their loads.

Thanks to the floating boom, the disc-feed sails smoothly over rough going, without transmitting strains to the loader chassis.

On both the "25" and the larger "42"—it means loading speed and longer life.

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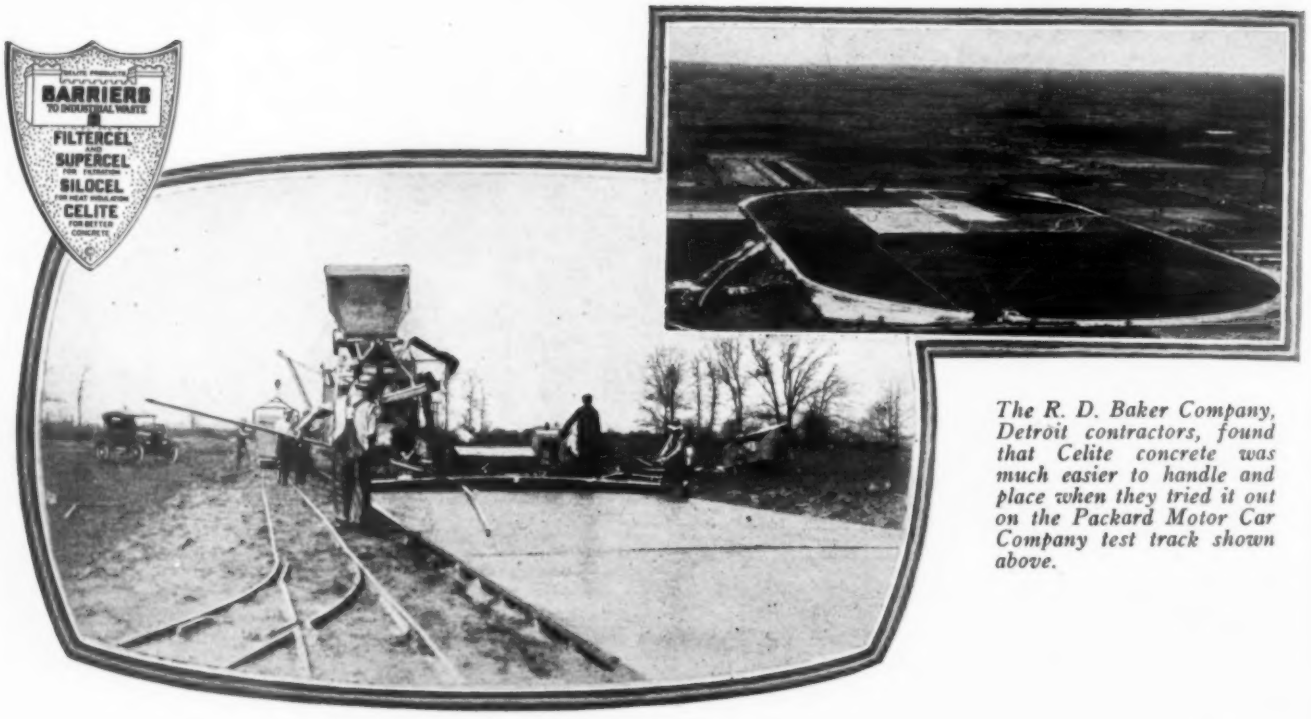

The R. D. Baker Company, Detroit contractors, found that Celite concrete was much easier to handle and place when they tried it out on the Packard Motor Car Company test track shown above.

Celite makes "dry" concrete easy to handle

The approved workability agent Celite will simplify many of your concrete placing problems.

It fattens up "dry" mixes—makes them easier to place and holds the water in the concrete so that it does not interfere with surfacing and floating.

The R. D. Baker Company found this powdered material particularly valuable in the construction of the Packard test track, pictured above, where the angle of the roadbed was so steep that plain concrete, watered enough to make its placing possible, invariably sluffed off. You will find that Celite saves a great deal of labor and trouble wherever you place concrete. Dozens of State, County and Municipal Highway Commissions have approved the use of this material, because it insures uniformity, prevents segregation and speeds up placing operations.

Write for our Engineering Service Bulletin Z-320 on workability in concrete.

CELITE PRODUCTS COMPANY

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(From an Editorial in Oil Engine Power)

"HABIT is a powerful servant, but a dangerous guide—HABIT enslaves the intellect, hog-ties facts and clogs initiative—HABIT, the blind drudge of inertia and halftruth, is cracking the whip of antiquated precedent over the power plants where steam is worshipped as a fetish and a cure-all.

"The STEAM HABIT is a capricious mistress, and while men know her weaknesses and her strength, her foibles and her limitations, they still take the line of least resistance, and pledge allegiance to steam rather than investigate new developments which THEY happen to know little or nothing about.

"An embarrassing thought for the progressive power executive—is he a slave of the steam habit?"

Until recently contractors and shovel engineers in Chicago have been hog-tied to steam-shovels, but the last year has seen a decided change; progressive contractors are learning from pocket-book experience that gas power shovels are here to stay. Waukesha Engines are used in more power shovels than any other make. There must also be a reason why they are chosen by builders like Erie, Link-Belt, P & H, Thew and Universal, who are very jealous of their reputation. Write for our "Shovel Engine" Bulletins and find out.

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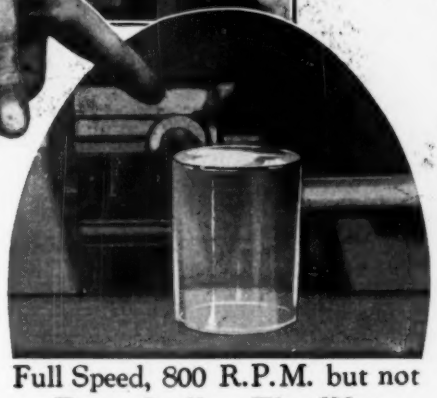
Vibrationless operation of your portable compressor means trouble-free service. It means dependable air power, freedom from delays, and protection for your profits—to say nothing of long life for your compressor.

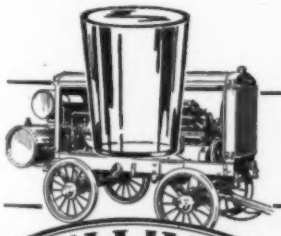
And now in the portable compressor, as in the high grade automobile, vibration has been reduced to almost zero.

The picture shows a *stock* Sullivan 310-ft. capacity portable, running at full speed. A glass of water filled to the brim is standing on the frame. The wheels are not blocked, and the compressor is not braced in any way. Yet the surface of the water barely ripples, and not a drop is spilled.



Full Speed, 800 R.P.M. but not a Drop Spills. The Water Test Shows One Reason for the Superiority of the Sullivan Compressor

There are reasons why Sullivan Portable Compressors are *vibrationless.* The catalog explains them.



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the Vibrationless
COMPRESSOR

Sullivan Machinery Company
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Branch Offices in 22 Cities — Local Distributors in 78 Cities

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Send this Coupon

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The charming hilly tract, embracing 160 acres, adjoins the estate of Mrs. Antonio Moreno, owner of the development which bears the name of the famous film star. It consists of four subdivisions, all with beautiful winding drives of portland cement concrete.

The main drives are 40 feet wide, and comprise a 24-foot concrete pavement and a bridle path. Secondary streets are 24 feet wide and have a 20-foot pavement.

These concrete pavements—even-surfaced, distinguished looking, durable — make the hillside homesites readily accessible and are among the best sales arguments and attractions to the section.

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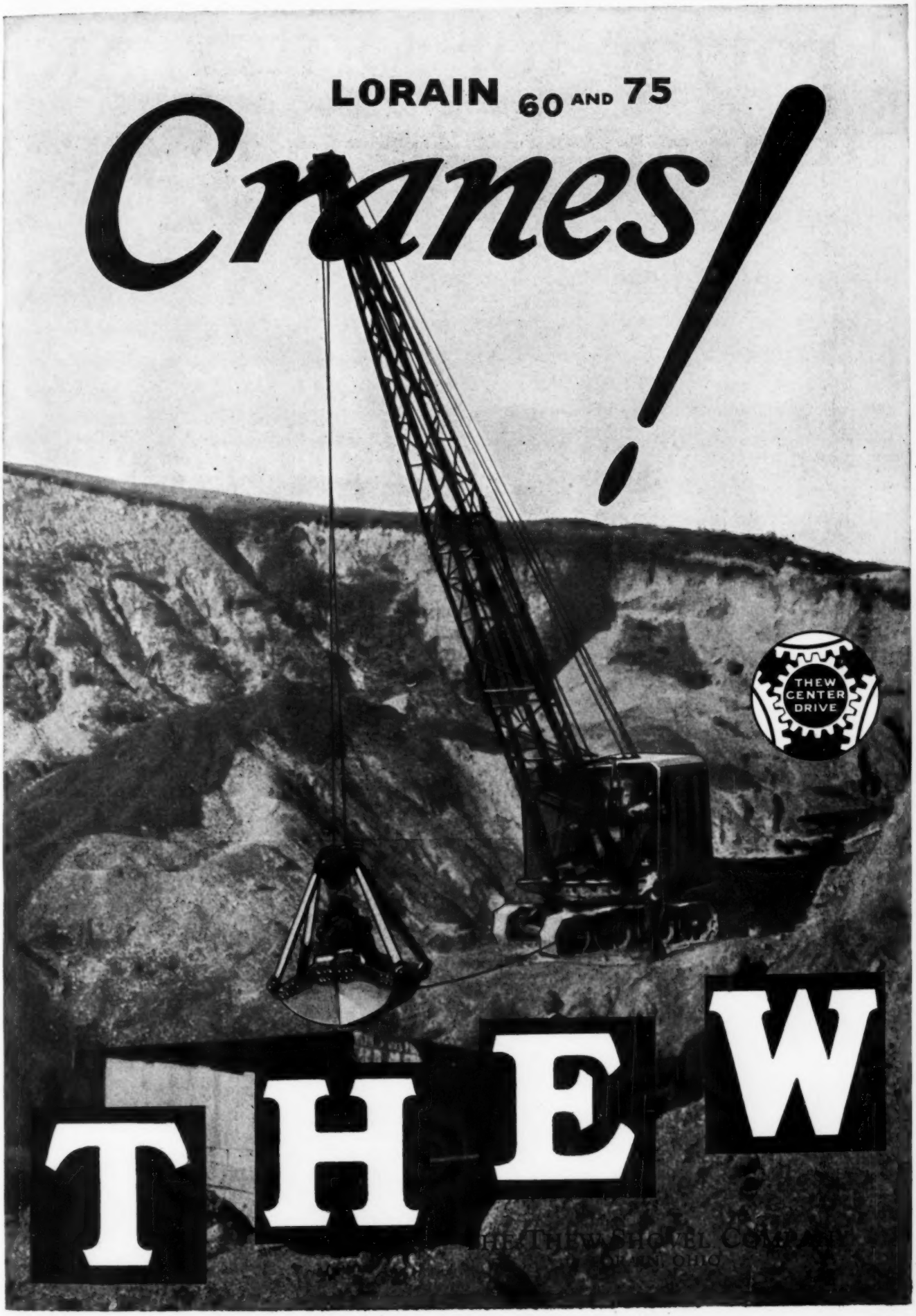
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Be sure in making up your 1928 Budget to provide appropriations for a sufficient supply of *Dowflake*—the road-man's best friend.

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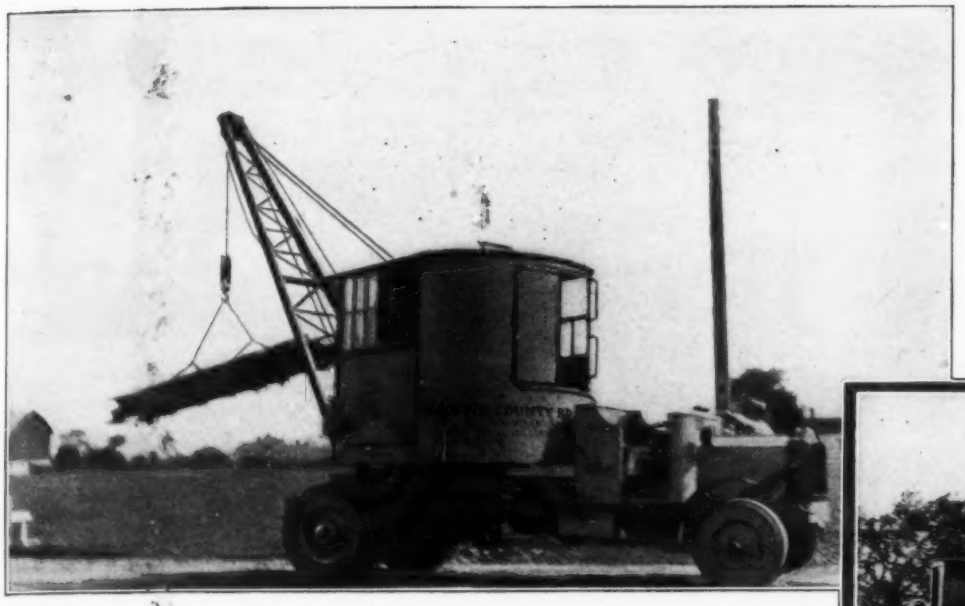

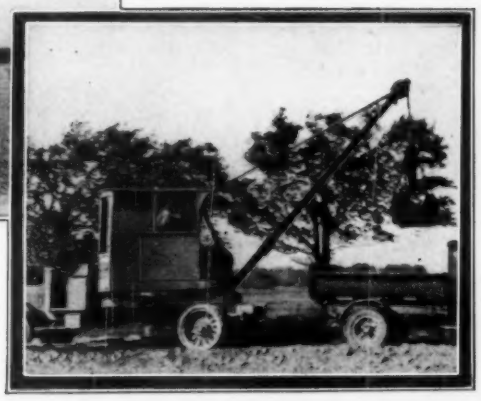

Playing square

with the Taxpayers of Wayne County

Wayne County, Michigan — the cradle of good roads — in the highway world is, perhaps, the best known county in the United States. Certainly it is the best paved, which can be attested by anyone who has driven over its 507 miles of broad, well maintained, hard surfaced arterial highways.

Edw. N. Hines, Chairman, John S. Haggerty and Wm. F. Butler, Commissioners, with Leroy C. Smith, Chief Engineer of the Wayne County Road Commission, have at their command, probably as much or more money per capita than any other county in the country.

They build the best roads and use the best machinery to build them with. They don't have to skimp in their expenditures but *they spend their money wisely.*

For instance, they could have spent 50% more for the two truck cranes they recently purchased, but they didn't. They knew that the extra 50% would not have added an iota to the value of the cranes.

They played square with the taxpayers and bought ORTONS.

Not without investigation, of course, although the 30 or more ORTON MODEL "V" Cranes in the vicinity of Detroit were irrefutable testimonials. But having purchased 25 or more cranes, shovels and other road building machinery in the past 20 years, they were wary. So they instituted one of the most rigorous and exacting investigations accorded any machine with the resulting purchase as before mentioned.

What does this mean to State, County and Municipal Highway Engineers and Commissioners? Just this: You can't face the taxpayers in your community and tell them you have spent their money economically unless you have investigated the ORTON Model "V" Truck Crane. And what is true of the Truck Crane is also true of the Locomotive Cranes, Gasoline Shovels, Cranes and the Buckets that ORTON Builds.

The coupon brings a copy of our new Truck Crane Bulletin. Fill it in and mail it today for your copy.

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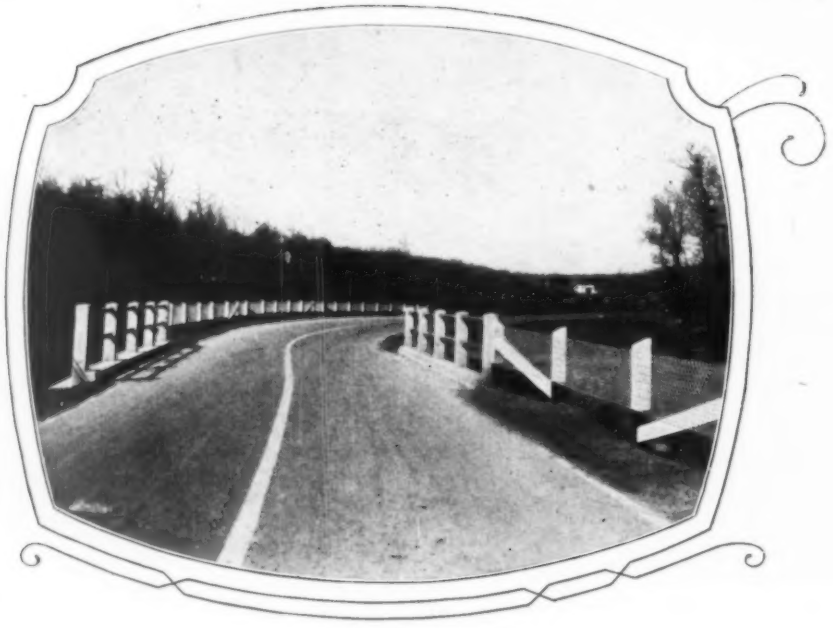

Adopt a Safety Program —for 1928

Each year there is a more imperative demand for genuine protection at highway danger points. Great as the task may be, sooner or later it will be necessary to modernize your entire system.

Why not start now on a definite schedule for installing Cyclone Road-Guard? Plan a certain number of installations per year to keep up with the needs of faster, denser traffic. Don't let increasing accidents make highway protection a public issue. Write today for facts on the Illinois highway program.

Use These Impact Tables

Send for reprint of test conducted by Prof. Wm. J. Putnam (Univ. of Illinois) on power of Cyclone Road-Guard to absorb impacts. Shows length necessary to hold cars of various weights traveling at different speeds.

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The new Kalman Road Chair supports marginal rods at the exact specified distance from sub-grade and forms—and it makes setting so fast and easy that costs are cut to an unusually low figure.

Just slip a rod in the loop of the Kalman Road Chair. Then push the stem of the chair into the ground. The sliding lock is automatically forced up against the bottom of the rod and clamps it in position.

That completes the setting job. Each rod is held at the same distance above the sub-grade. And the horizontal arm of each chair keeps the rods at the specified distance from the forms.

Because it provides such speed and accuracy, this new Kalman Road Chair is everywhere being approved by road contractors. And it is but one of the many concreting and reinforcing helps developed by Kalman in connection with *Corrugated Bars.*

A sample will show you in more detail how the new Kalman Road Chair can help you. Send for it today.

KALMAN STEEL COMPANY
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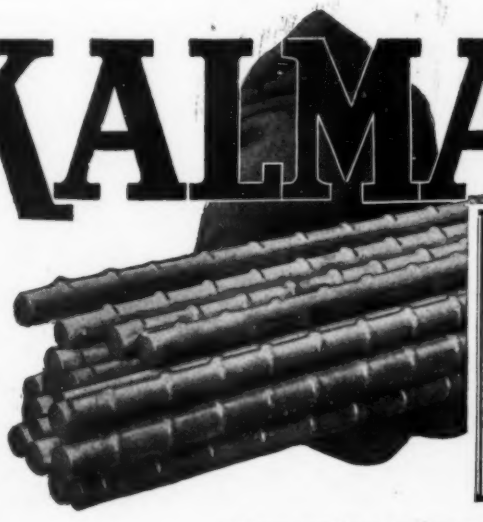
KALMAN STEEL



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The Lifeline of the Highway

Only Page Hi-Way Guard has the distinctive square mesh that provides the utmost in safety —that elongates according to the force of the blow, saving lives and reducing property damage to a minimum.

Keeping abreast of progress, road commissioners and engineers in every state are replacing wooden guard rail and other substitutes for safety with "The Lifeline of the Highway" —through which a car has never left the road.

Page Hi-Way Guard is easily erected and easily repaired. It offers many exclusive advantages for the protection of bridge approaches, embankments, road terminals, river banks, dead end streets, parks, etc. Write for sample and literature.

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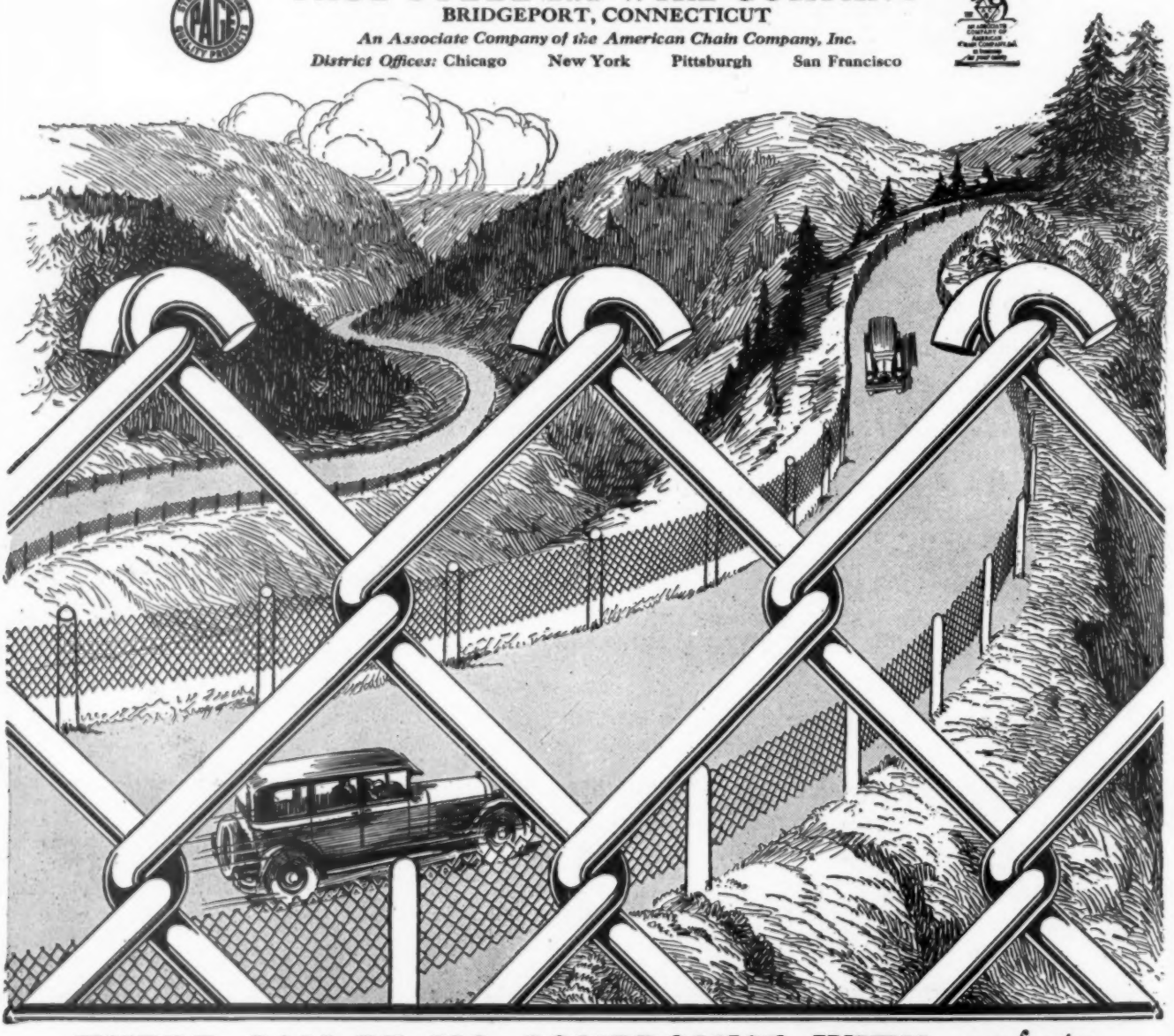
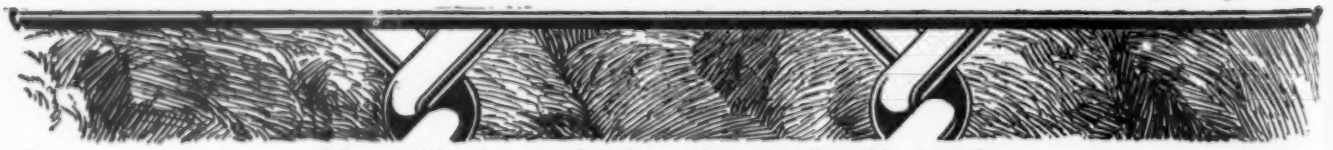


THERE CAN BE NO COMPROMISE WITH *safety*



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Joints That Resist Wear

Webbed Joint

A superior product, that offers increased rigidity without the loss of proper resiliency and resistance to traffic and wear necessary to the correct functioning of an expansion joint. Particularly desirable when only ⅛" or ¼" fillers are installed, in view of the additional rigidity and strength produced by the webbed sides.

The webbed sides are formed by cementing small strips of saturated felt on the surface in a brick-like formation, the strips on opposite sides of the joint being placed in a staggered relation so that each separation of the felt on one side is reinforced by felt directly opposite. The felt in this position maintains the rigidity produced by a solid sheet, without acting as a separator between the concrete and the mastic core. Even a slight compression causes the mastic core to become exposed between the felt webs and come into contact with the ends of the slabs, thus reducing the tendency of the core to be forced out of the top.

The old saying about a chain being no stronger than its weakest link might well be paraphrased to read "A concrete road is no more enduring than its weakest joint."

An expansion joint that fails to function, that disintegrates with the changing weather, and that wears away under ordinary traffic conditions, exposes the concrete slabs to rapid erosion and cracking, and highways that should be enduring stretches of concrete soon become unsightly and dangerous roads of travel.

Servicised Expansion Joints do not wear away. They consist of the highest grade materials; are carefully manufactured according to specified standards, and are guaranteed to function under all conditions.

Before you lay your next road send for the "Servicised" Catalog.

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The bituminous material is refined at our own factory and a material having penetration of 22-27 at 32 F. and a melting point of 240-250 F. is obtained through the proper selection of fluxes and careful operating control. Without exception, TYPE B joint is made from materials whose value, strength and quality are not even approximated by those used by other manufacturers.

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EXPANSION JOINTS

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"If I were a paving contractor, I'd work my hardest to land a brick job on some prominent road in my neighborhood and then I'd make sure it was built just as good as I could make it. And when I had finished it, I would arrange to have signs erected at intervals along that road telling the public just who it was that built it and built it so well.

"What would I get out of it?

"Plenty.

"In the first place, it would give me a valuable reputation in the community, which would help me with my neighbors, with other business men and with my banker. In the second place, I'd get some solid personal satisfaction out of driving my friends over that road on summer Sundays. And in the third place, I'll wager I'd get invitations to bid on roads in adjoining sections and be a favored bidder as well."

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The Pavement that Outlasts the Bonds

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Actual service conditions are more nearly reproduced than ever before by this modern apparatus in the Association's laboratory.

There are two big reasons for ARMCO *research*

MOST engineers and officials are acquainted with the movement inaugurated by Armco to "Look under your roads."

These investigations, conducted by experienced and unbiased observers, have recorded in the past six years the performance of many thousands of culverts. These records have proved conclusively that Armco Culverts do endure.

But Armco research does not stop with field investigation. Exhaustive tests and laboratory experiments have been made. The result has been the development of practical drainage information which consistently saves money and insures better service to users.

Among the outstanding recent achievements are Armco flexible subdrains—Armco heavy-gauge culverts—Armco special fittings. Equally important has been the gathering and recording of data which assure a satisfactory solution for every drainage problem.

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Predominant in use — because predominant in quality

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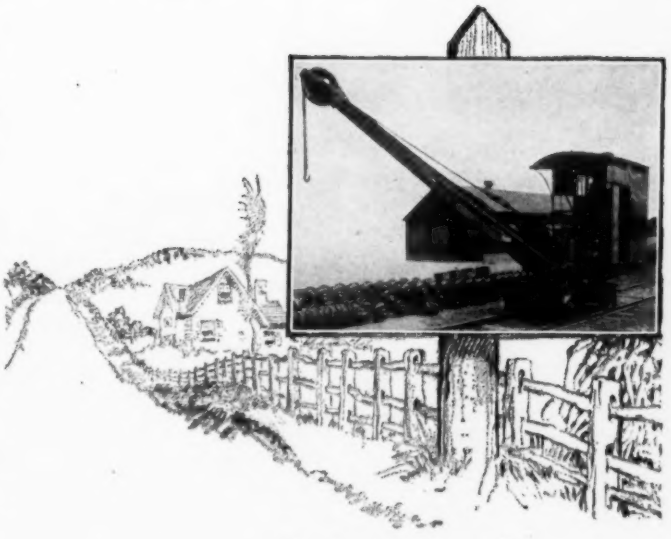
of handling Progress

Fifty years ago Industrial and Brownhoist built their first handling equipment. These first machines, to be sure, took no beauty prizes but they did give many years of satisfactory service.

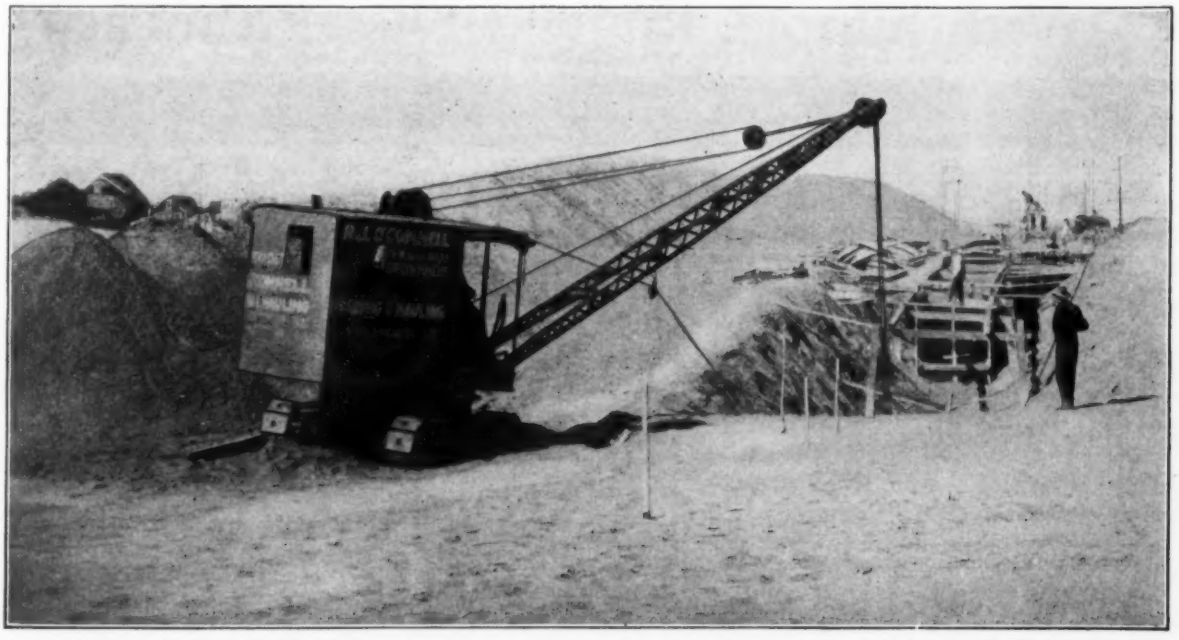
Handling problems and machines differ from those of a few decades ago. Greater tonnages have made necessary bigger and better cranes and the diversified needs of industry now require many different types.

Having set the standard in this important field for half a century, Industrial and Brownhoist are now working as one big organization in order to even better carry out this purpose. As a result, we can now assure you greater material handling economies than ever before. May we be of service to you?



Products

Locomotive Cranes, 7½ to 60 tons capacity, Wrecking Cranes, 75 to 200 tons capacity, Gas Shovels, ½ to 1¼ yards capacity, Bridge Cranes, Heavy Dock Machinery, Creeper Cranes, Pile Drivers, Belt Conveyors, Chain Conveyors, Grab Buckets.



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General Offices: Cleveland, Ohio.

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Steady Work and Big Production

With Simple, Rugged Diesel Shovels

The surprising *strength* and *sturdiness* of Bucyrus Diesel shovels is due entirely to their simple construction.

This *simplicity* is the result of experienced designers and builders. Bucyrus built and introduced the *first* Diesel driven shovel in 1922—years earlier than any other manufacturer.

And the simplicity in design means *exceptional* strength and ruggedness.

You'll find every Bucyrus Diesel with the right kind of steel in the right place. The special steels used are annealed or heat treated whenever it is advisable to do so. This practice gives the simple, well balanced, Bucyrus Diesel parts great strength, sturdiness and long life.

For the Bucyrus owner, then, the Diesel machine means *steady, uninterrupted digging and big production.* If you haven't seen the "Facts and Figures" booklet send for it today. Address Dept. E.

What is Bucyrus Doing for the Contractor in 1928?

See Booth AA-20 Main Floor, Arena Exhibition Hall, Cleveland, Ohio

Jan 9-13 Inclusive

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BUCYRUS COMPANY, South Milwaukee, Wisconsin

Builders of Excavating Machinery Since 1880

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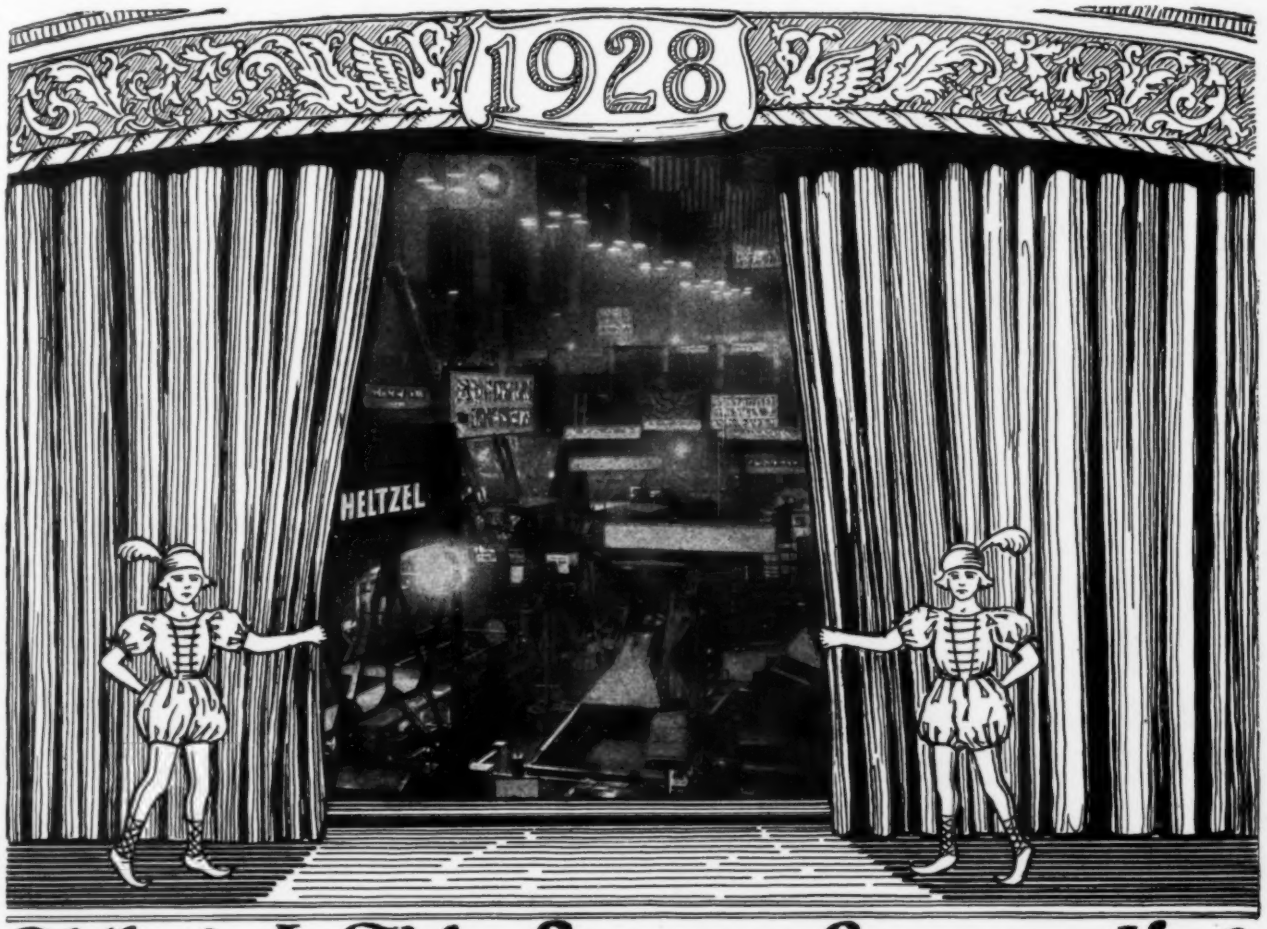


What Is This Secrecy Surrounding Heltzels 1928 Road Show Display?

WHAT are these rumors going 'round that HELTZEL has developed a new steel road form which is years ahead of the times? A wee small voice says wait, examine and see it with your own eyes.

What is this mechanical joint machine for installing longitudinal and transverse joints in city streets and roads and this new collapsible form for the same purpose?

What are these new yoke type curb forms?

And material handling equipment! Absolutely no details until the road show. But, listen! So much contractors' equipment is going out of date in 1928 that every contractor and engineer will wonder what is coming next.

If you can't be at the show, write HELTZEL and put your name on record for any of these new HELTZEL catalogues.

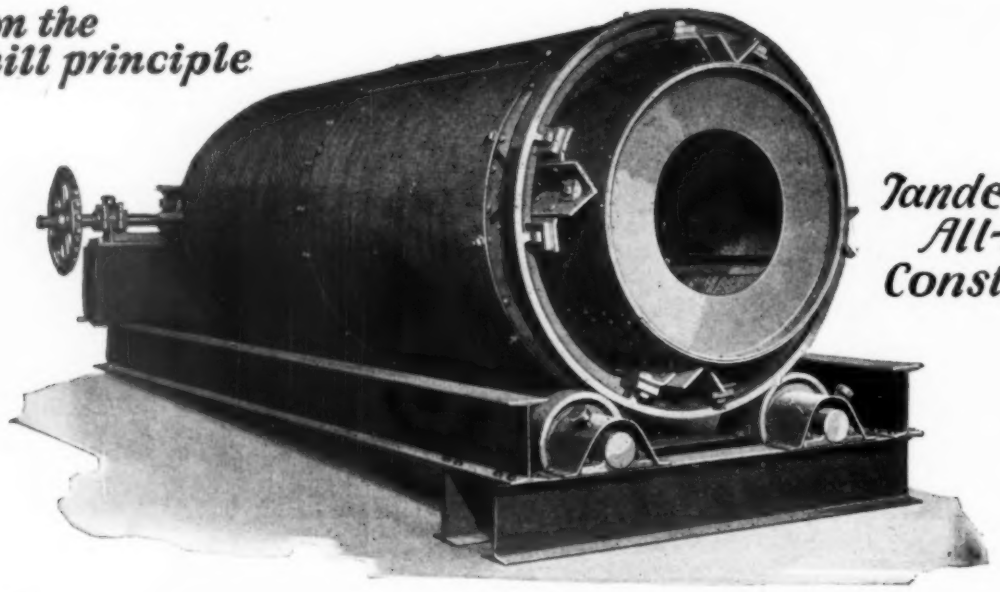
Modern Road Building Equipment.
Modern Street Building Equipment.
Modern Material Handling Equipment.
No copies released until after January 10, 1928.

See HELTZEL display at Booth AA4, Auditorium, Cleveland, Ohio, Road Show, January 9th to 13th, 1928

THE HELTZEL STEEL FORM & IRON COMPANY, WARREN, OHIO

HELTZEL

built on the ball mill principle



Tandem Jacket-All-Metal Construction

Washes Out the Clay

new washing agency solves old problem

Successfully

The entirely new washing agency employed in the Telsmith-Ajax Washer (all-metal construction) makes it a better scrubbing device than either the conical or cylindrical washers. Washing out the clay has always been a difficult problem. In the ordinary rotary washer the sticky clay gathers up sand and rock particles; and continued rotation produces hard, compact balls.

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Another big Ajax feature is its ***tandem sand jacket.*** One jacket—perforated with 3/16 to 1/4 in. holes and surrounding the scrubber—passes the sand. The second jacket, of the same diameter, enclosing the first stone screen, removes ½, ⅜, ¾ or inch size. By locating these smaller perforations outside the main screening barrel, the small rock is prevented from carrying over—insuring more accurate classification.

Bulletin A. W. 3 will enable you to better visualize the details of the Telsmith-Ajax design and its substantial ***all-metal*** construction. Mailed without cost or obligation. ***Write*** for it ***today.***

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This new Novo is not an ordinary road pump. It is *engineered* on a new idea to meet every paving requirement. It can shoot 110 gallons of water to your paver every minute—or 66,000 gallons every 10 hour day. And new Flud Oild Lubrication makes these *"gallons certain."*

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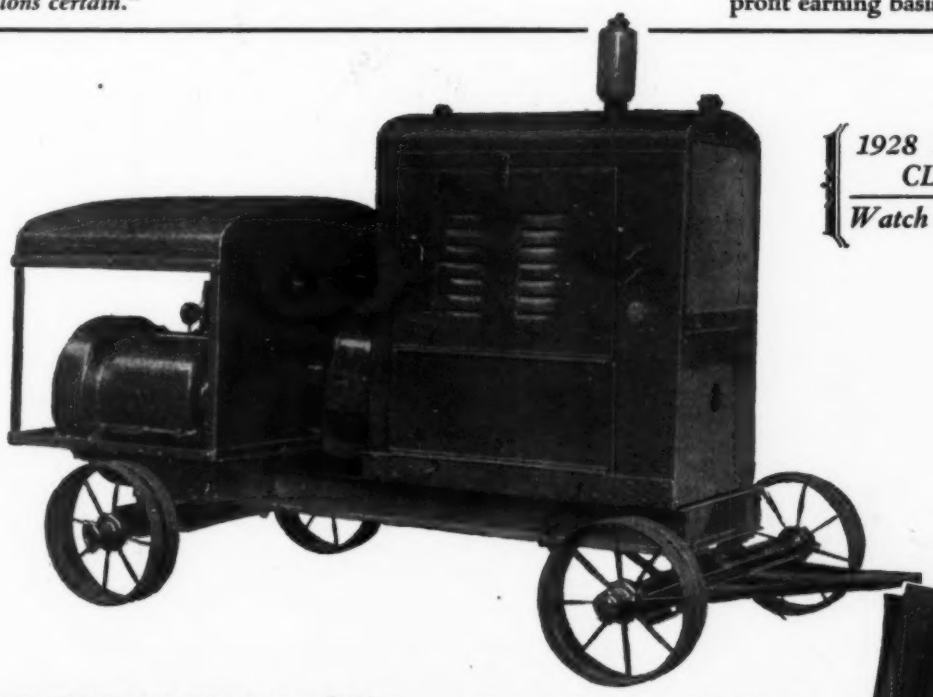

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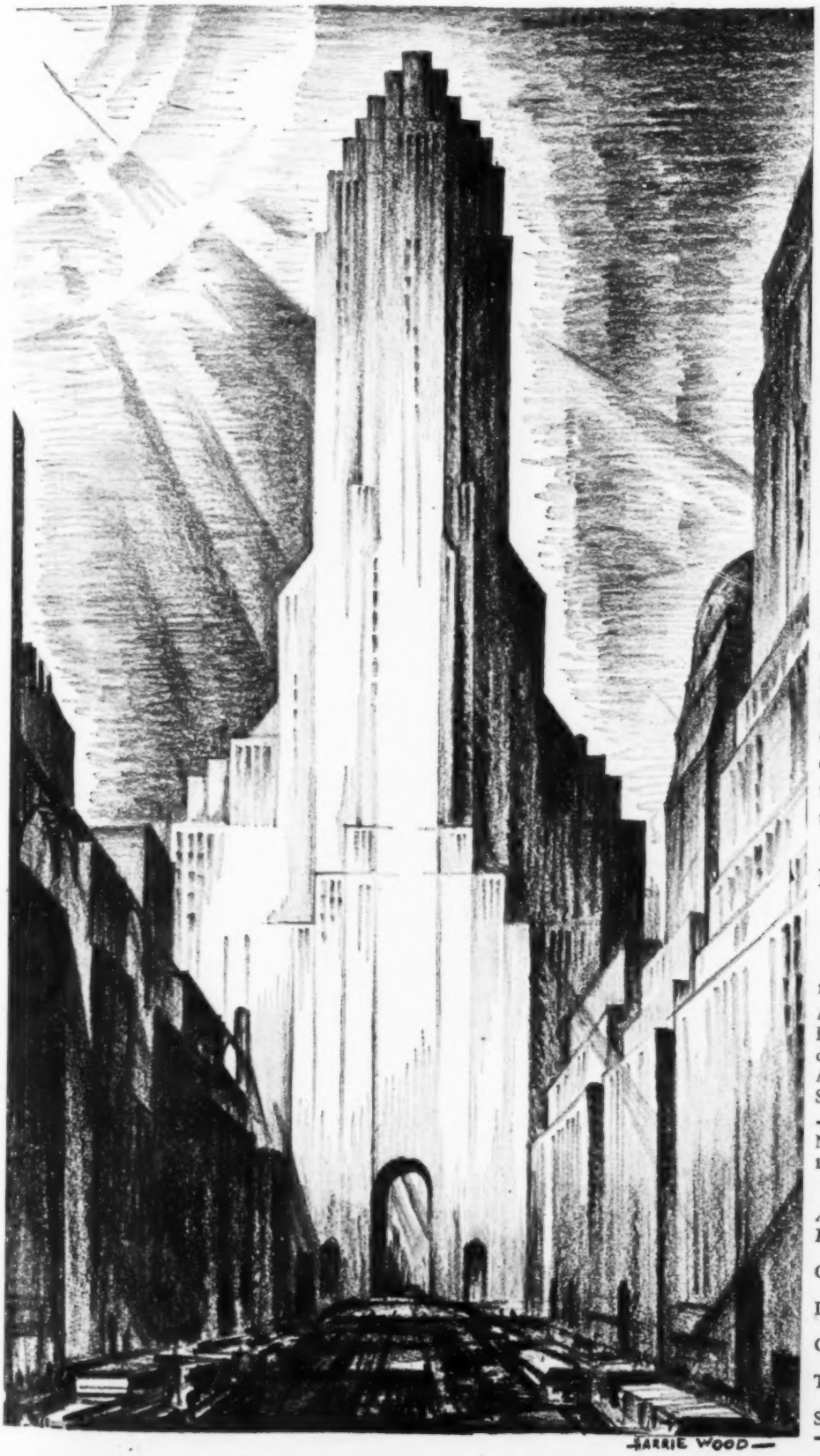

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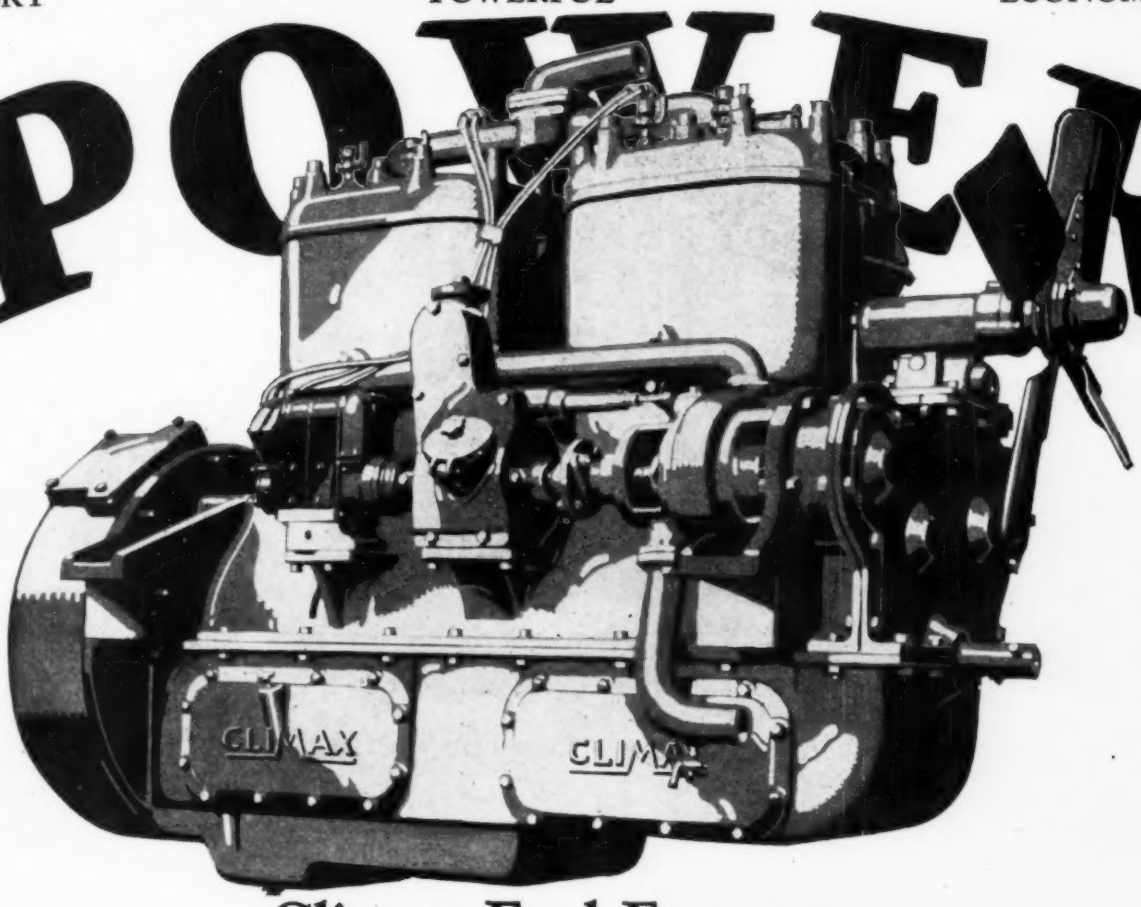

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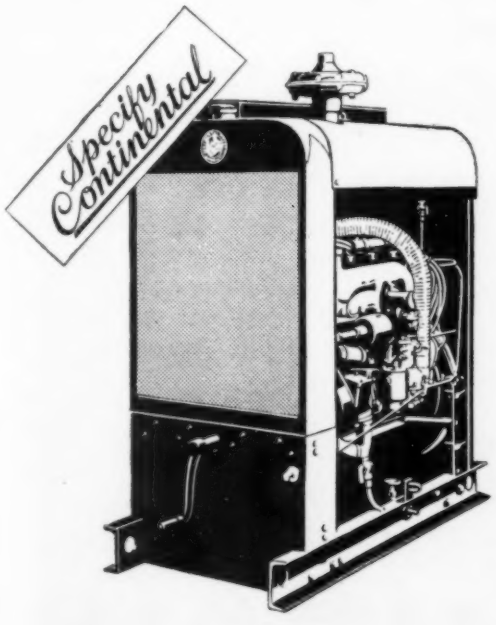

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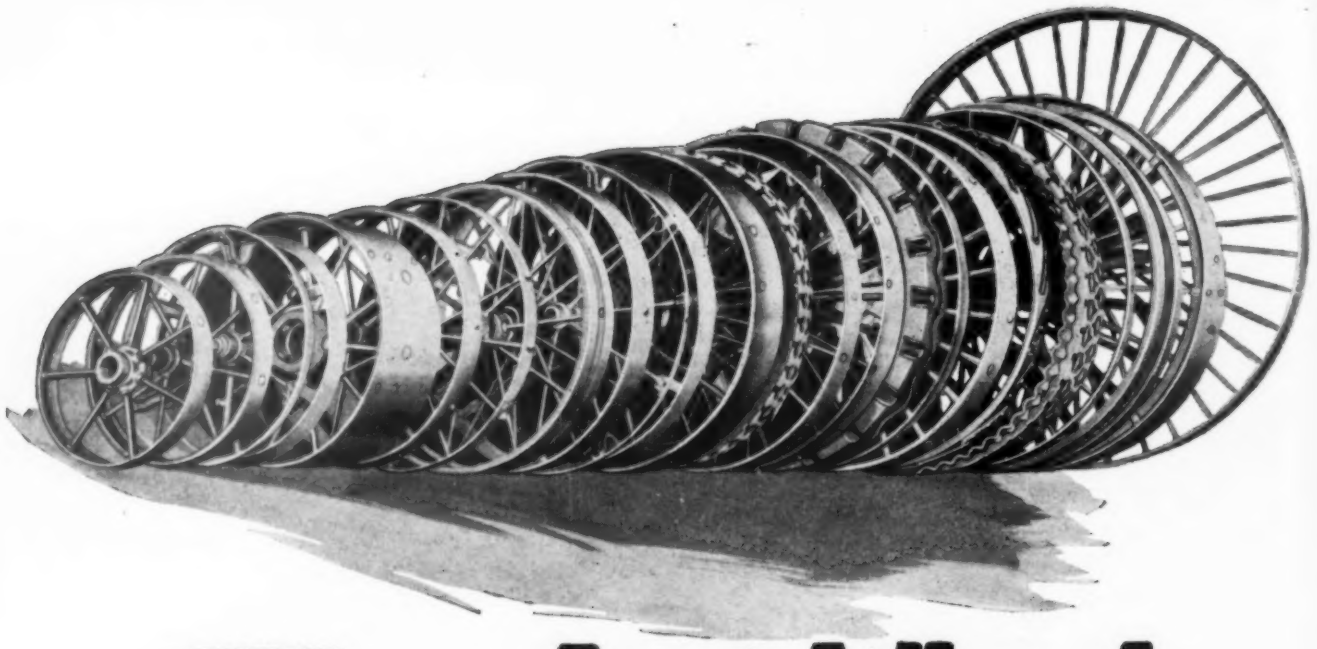

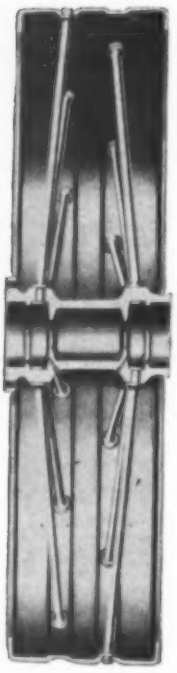

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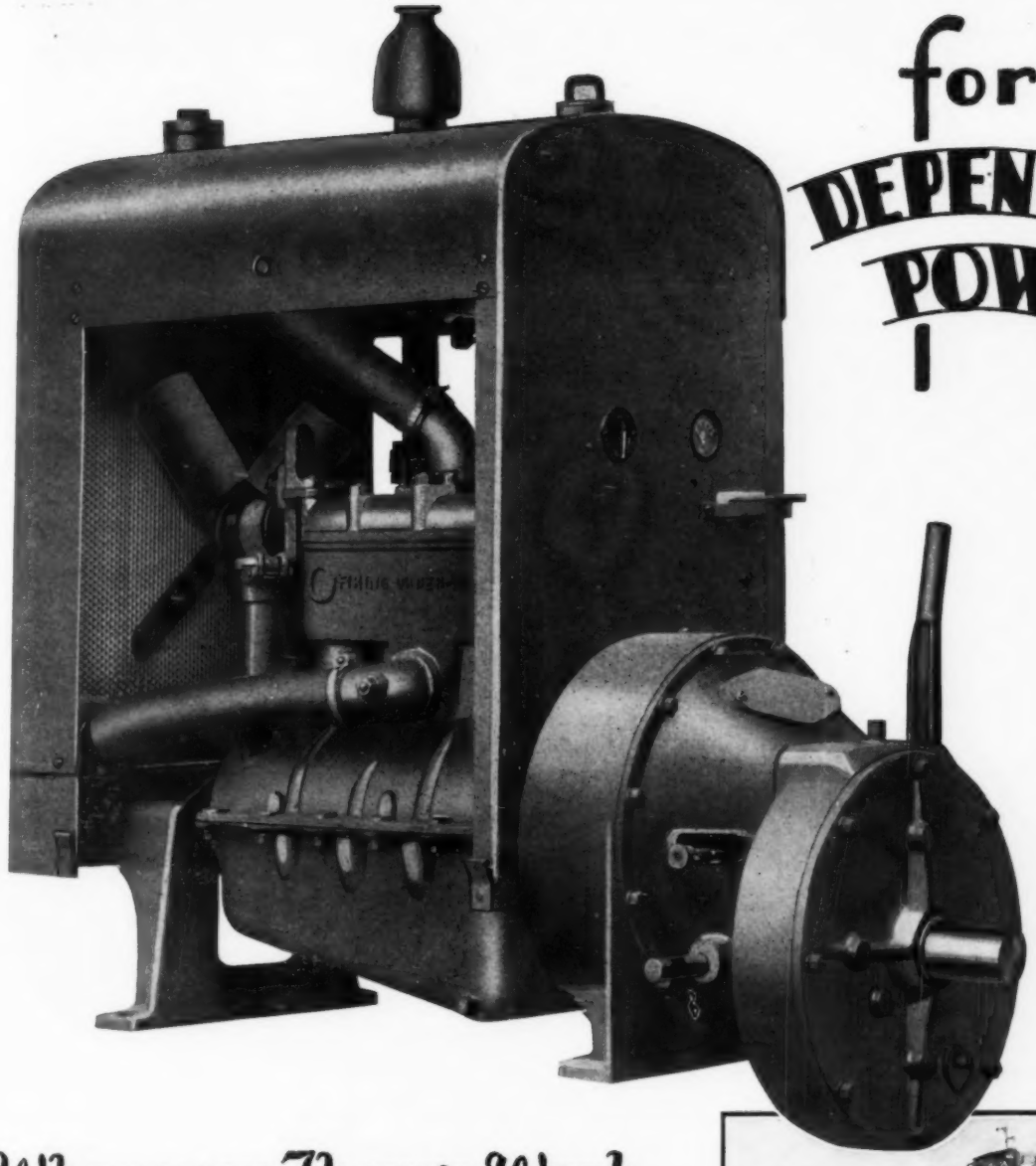

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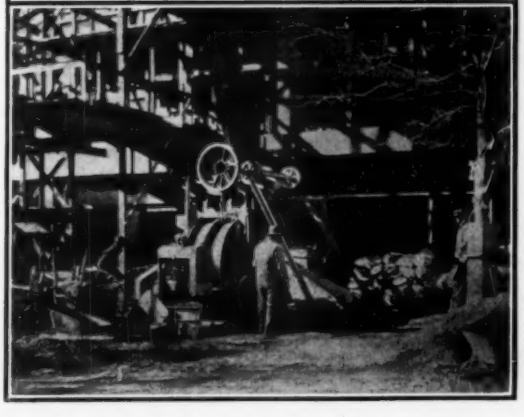

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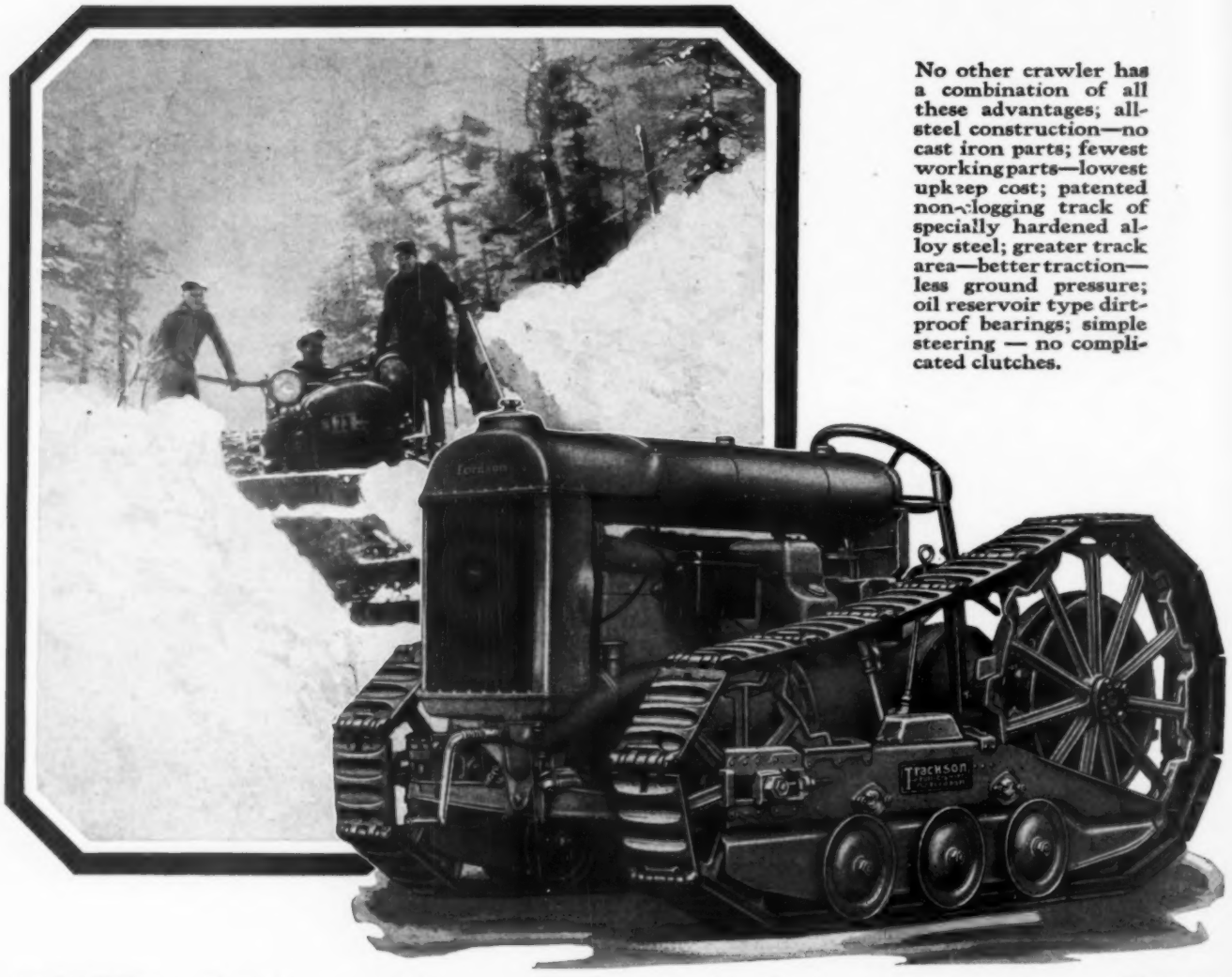

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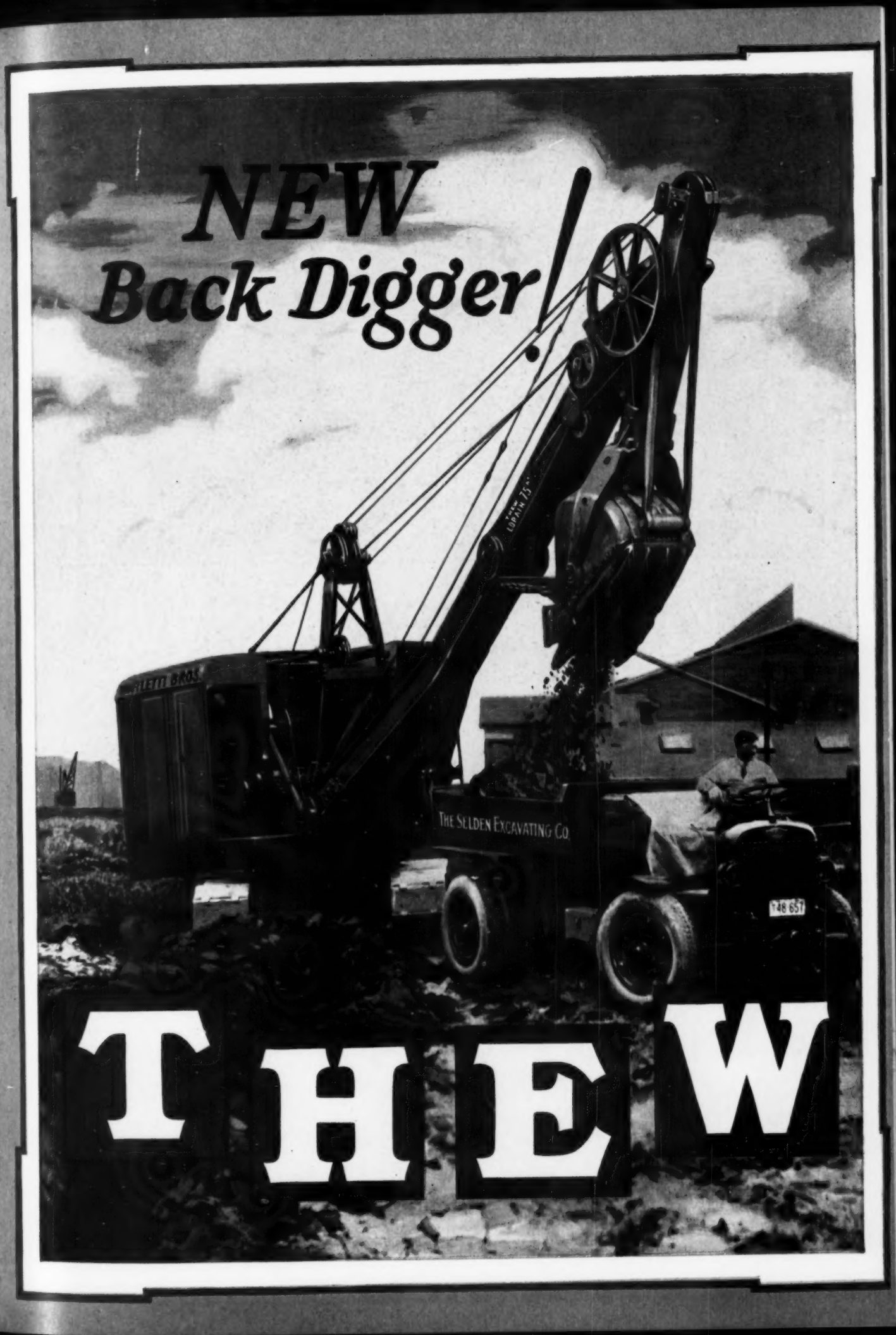
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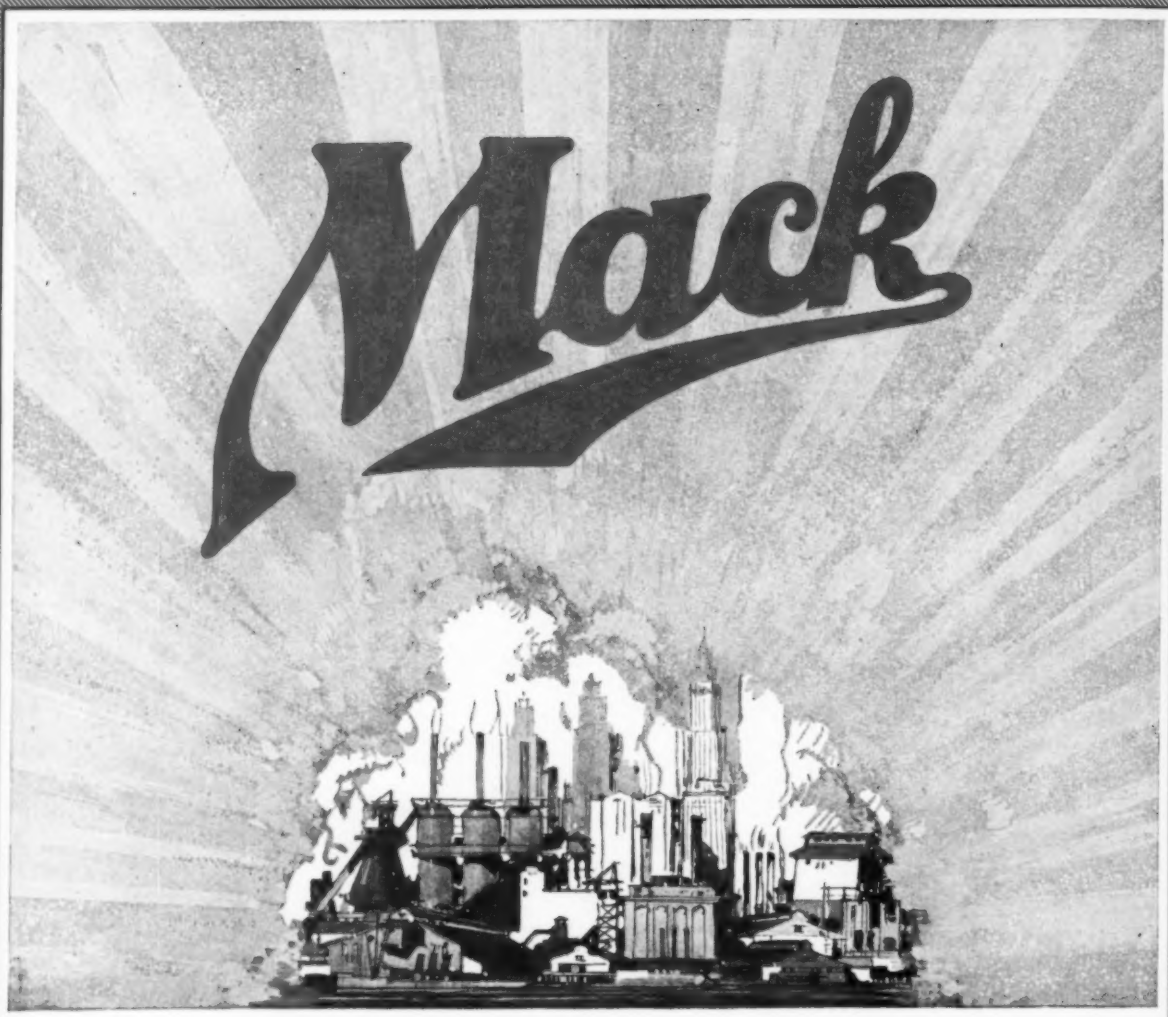

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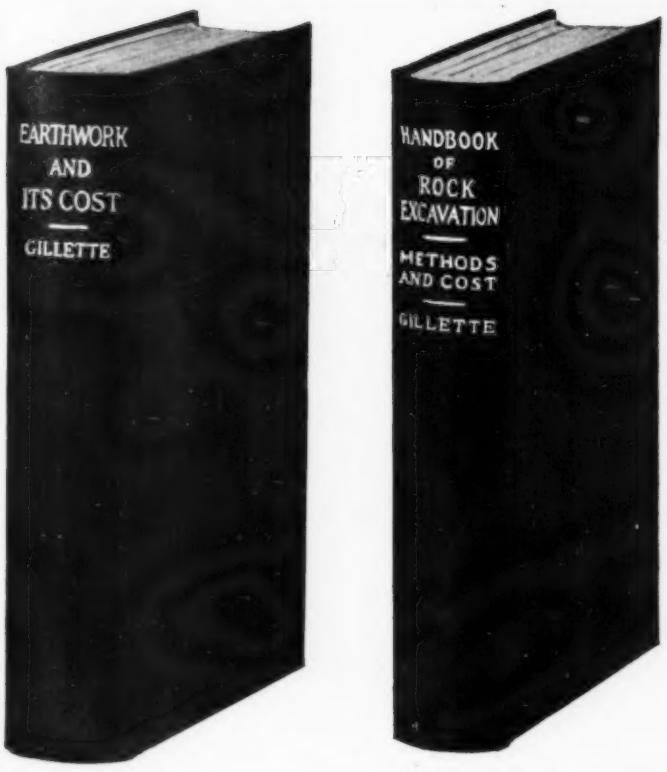

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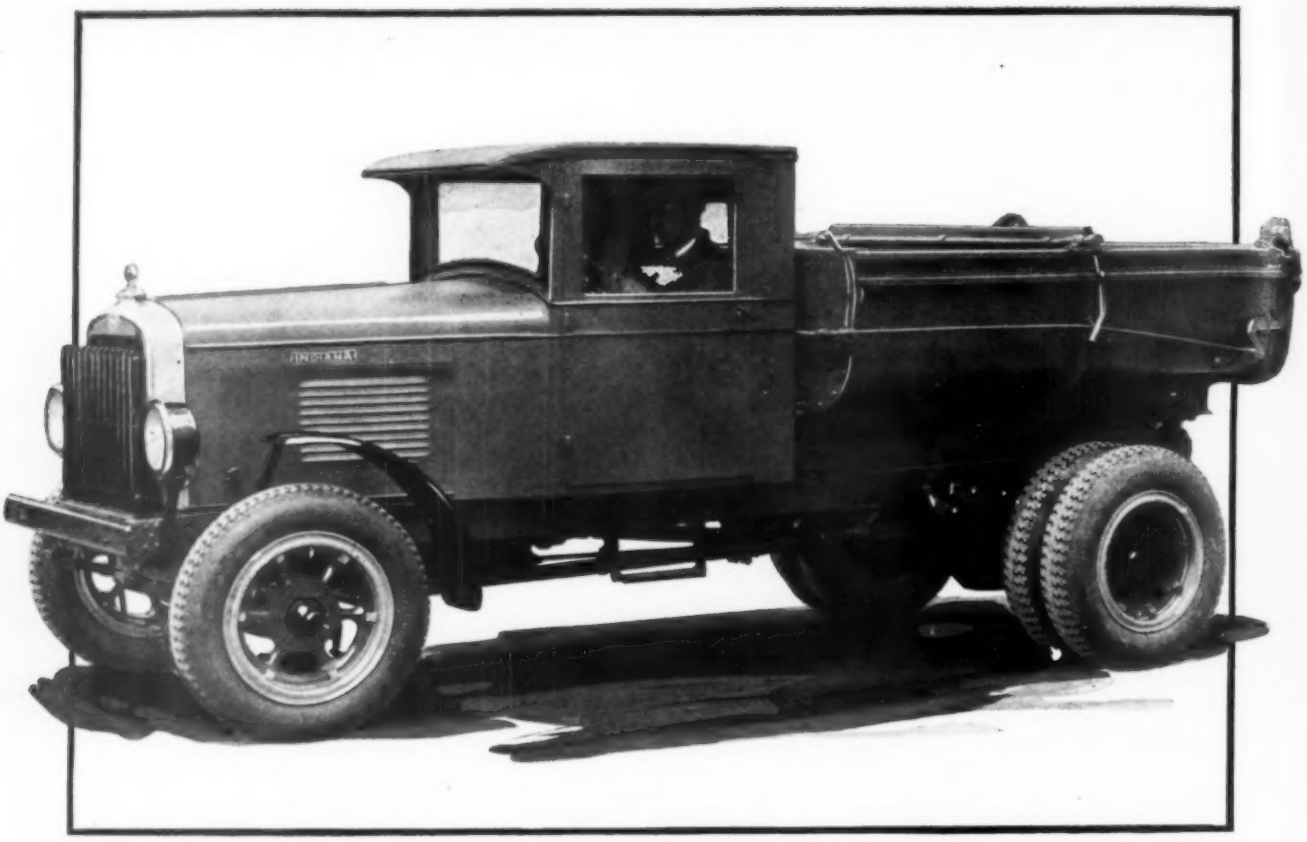

For 1928
Consider Your Truck Costs

NEXT YEAR, you will need new trucks. Old ones must be replaced. More trucks must be added to take care of your increased business.

When you consider replacing your old equipment—or adding to your present fleet—check your present operating costs against those of INDIANA users. You'll find that INDIANAS will save money for you.

Then make a check on the basis of dependability. You'll find that INDIANAS now in service have a performance record far beyond your expectations.

We believe we can prove to your satisfation that INDIANA Trucks are more dependable and more economical than your present equipment. You owe it to yourself to investigate our claims. Won't you write us for further information?

See the display of INDIANA ROAD BUILDERS at the American Road Builders' Association Convention in Cleveland, January 9th to 13th.

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4 and 6 Cylinder Models

INDIANA TRUCKS

1 to 7 Ton Capacities

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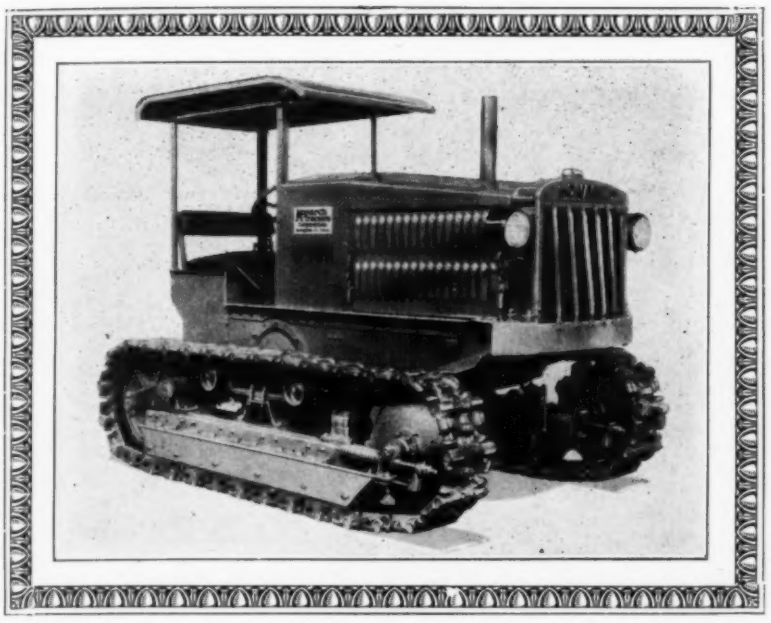
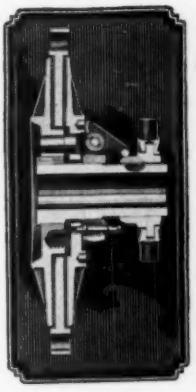


Six Ton Monarch tractor equipped with Twin Disc Clutch.



TWIN DISC CLUTCHES

Every One A Special

EVERY Twin Disc clutch installation is specially engineered by the builders of the machine and our own engineers, working together.

One of our principal requirements is *ample clutch capacity.* The clutch must *never* fail. The power plant *must* be protected from harmful shocks and strains. For these two good reasons we insist that the clutch shall have a work factor of 2. That is, it shall be capable of carrying twice the power the engine will develop.

This is one of the reasons why Twin Disc clutches perform so dependably and last so long in hard service.

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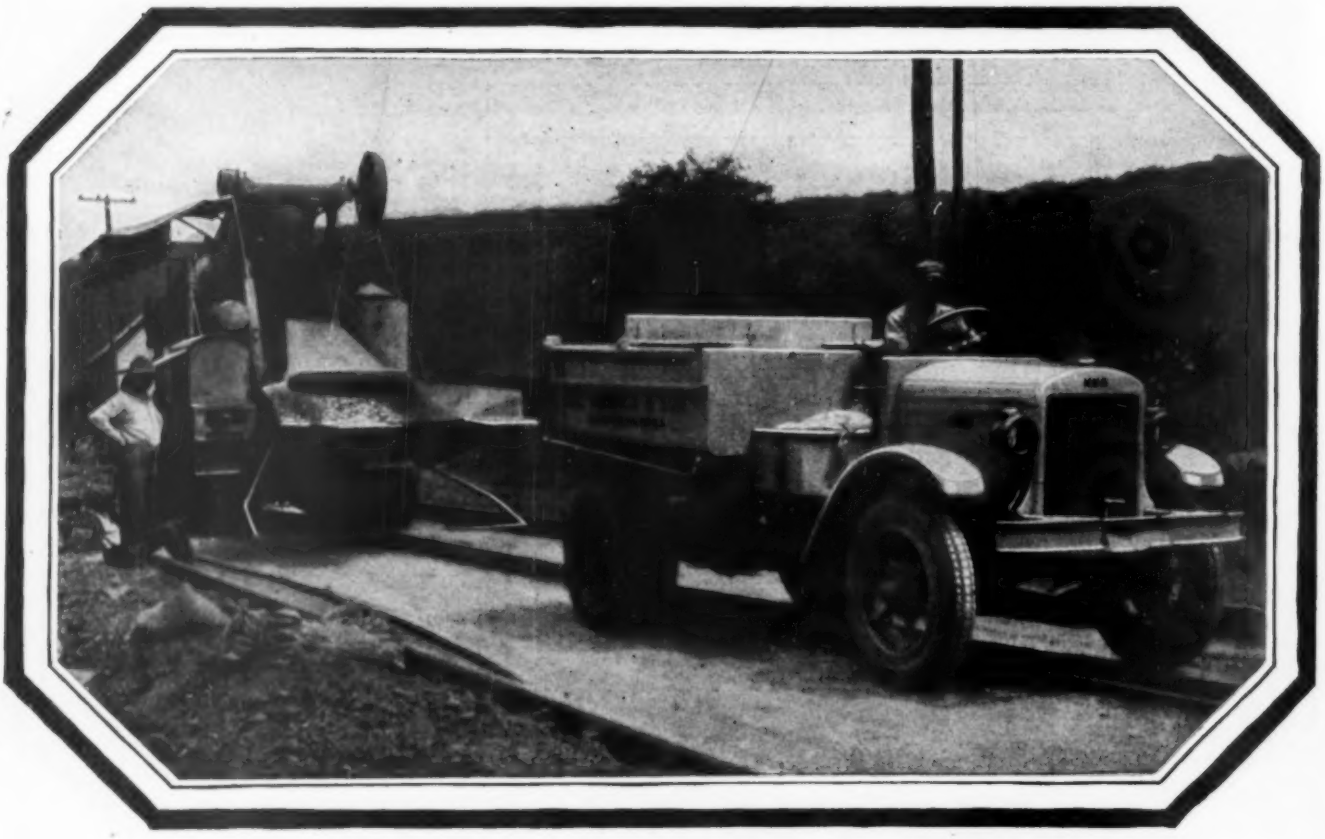

Model 80 Hug Roadbuilder in operation on Pennsylvania Highway

Hug Roadbuilding Transportation Equipment is *Designed* for Roadbuilding—

THE position of prominence gained by Hug Roadbuilder Trucks in the roadbuilding field is the direct result of specialization and concentrated effort in the building of transportation equipment designed to meet definite operating conditions. Speed—power—endurance and continuous service are the requirements of present roadbuilding transportation. A capacity for speed on the highway—power in a pull—endurance and continuous service are the qualities that have developed big Hug fleets where Hug performance has proved its superiority on the road job.

Visit the Hug Exhibit at the Road Show. The latest Hug Roadbuilder Models and other Hug equipment will be on display—including the Hug Ready Mix Concrete Rear Bottom Dump Body—the Hug Sub-grading Machine, Turntable and Template—Space—WW-58.

The HUG Co.

Highland, Illinois

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What You Get In An Adams

See Our Exhibit at the 1928 CONVENTION AND ROAD SHOW
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The popular Adjustable Leaning Wheel feature originated by Adams and which has forced straight axle grader manufacturers to imitations.

The advantage of 42 years of specialization in Leaning Wheel Graders—Adams Graders have long since passed the experimental stage.

The patented Adams "One-Piece" Rear Axle—much more simple and practical than the telescopic or pivotal types.

Equalizing Blade Lift Springs for easy blade control.

Strongly riveted, well-balanced and refined construction—Adams Graders are easiest to operate and outlast heavier but cheaply designed machines.

Play Safe and Buy Adams, the Graders of Known Value.

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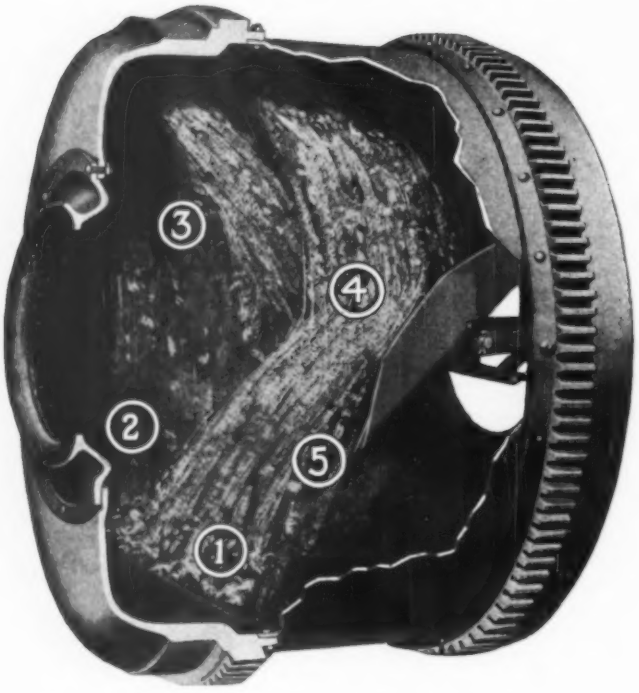
"The Original - A Proved Success Since 1885"

KOEHRING



5-action Re-mixing Action

1. Diagonal blades cut through materials, agitating them with a rapid folding action.
2. Diagonal blades carry materials upward with motion of the drum, spilling them back against motion of the drum, and at the same time carrying them toward discharging side of the drum.
3. Pick-up buckets carry materials to top of drum, and violently project them down to reversed discharge chute in a scattering showering action.
4. Materials again showered from reversed discharge chute back to diagonal blades on charging side of drum.
5. Diagonal blades again start the materials through a complete repetition of the entire mixing action—the distinctive, exclusive Koehring Re-mixing Action!

The Koehring re-mixing action is only made possible by the Koehring construction which pivots the discharge chute ***far enough inside the drum to return the materials to the charging side!***

When Inspection Says You Must—

WHEN quality of concrete is under rigid inspection——when vigilant inspectors or engineers set batch meters and mixing period according to uniformity and quality of concrete——then you'll find that Koehring Re-mixing Action means a lot to speed in getting concrete on to the subgrade! You'll find it is a big factor in getting more batches per day, more yardage on the subgrade!

No doubt about it, Koehring Re-mixing Action becomes more and more a speed factor as standards for quality concrete tighten and inspection becomes more rigid!

And in every other way too the Koehring is fast! Stop-watch the time from the start of the charging skip upward, *until* the last shovelful of materials is actually in the drum! You'll find the Koehring gives you something more than mere high speed skip travel—it *gives you actual* high speed *charging!*

Watch Discharge — No mere gushing of concrete at the start and then a decreased dribbling at the end of the batch! No—the big volume that comes down the chute at the start *keeps* coming to the last shovelful of the batch!

And up on the control platform is an operator who sees what's happening at both ends of the mixer—*sees* without walking about! His levers are in easy reach! Automatic Actions save him seconds, let him keep his mind and effort on high speed operation of the mixer *as a whole!* He gets SPEED—a fast steady sequence of charging, mixing, discharging, and distributing! One batch on the heels of another! And never a second's delay.

High speed as a unit! — fast in every function — and all the functions tied together by centralized, fast control—that's why the Koehring is the High Speed Paving Unit! —And behind high speed operation is *Koehring Heavy Duty Construction*—the greatest safety factor against breakdowns and delays you can put on the job! *Know the Koehring!*

SIZES

Pavers—7-E, 13-E, 27-E. Auxiliary equipment and choice of power to suit individual needs. Complies with A. G. C. Standards.

Construction Mixers—10-S, 14-S, 21-S, 28-S. Steam, gasoline or electric power. Mounted on trucks or skids. Rubber tired wheels optional. 28-S on skids only. Complies with A. G. C. Standards.

Dandie Mixer—5-S, 7-S:—5-S single cylinder, 7-S two or four cylinder gasoline engine. Power charging skip, or low charging hopper and platform. Rubber tired steel disc wheels or steel rimmed wheels. Complies with A. G. C. Standards.

Write for Paver Catalog No. P7

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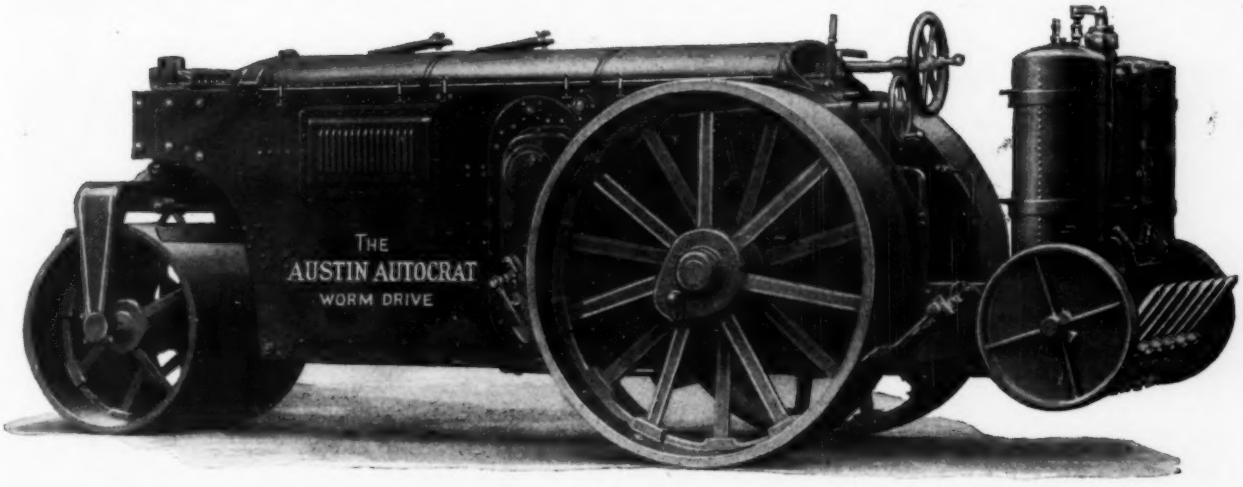
KOEHRING HEAVY DUTY

The New AUSTIN AUTOCRAT

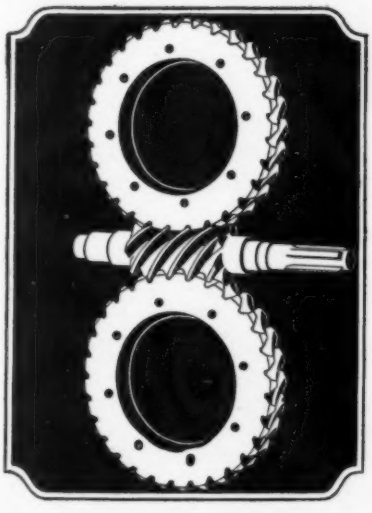


STREAM-LINE—WORM DRIVE

IMMEDIATELY noticeable is the pleasing stream-line design affording the operator unobstructed view of the work of both front and rear rolls. The deep frame side plates, same height front to rear, enclosing power unit and transmission completely, affording a protection from dust, dirt and the elements, as well as against petty thievery of such things as carburetor and magneto.

The outstanding feature of the AUTOCRAT, and the one that places it far in advance of all present motor rollers, is—

The Duplex Worm Gear Drive—



through which the power of the heavy-duty 4-cylinder motor is transmitted to the clutches, thence to the rear axle. New in its application to a road roller, but in almost universal use in the better grade motor trucks. Seven points of superiority:

1. Unexcelled in transmitting power.
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3. Simplicity.
4. Does not require expert attention.
5. Practically fool proof.
6. Silent in operation.
7. Free from undesirable vibration.

Complete information on this new roller is prepared for mailing. Drop us a line and let us tell you of the amazing possibilities of this great 10-ton roller.

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1907
America's first *3-wheeled motor roller.*

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America's first *tandem motor roller.*

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America's first *worm drive motor roller.*

THE AUSTIN-WESTERN ROAD-MACHINERY-CO. CHICAGO

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Send me the full information on the Austin Autocrat.

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Guarantee

Owen Buckets, properly installed and operated, are guaranteed to do a bigger day's work than any other bucket of the same weight and capacity—

—or—

Write your own guarantee!

THE OWEN BUCKET CO.

Read the above guarantee carefully. Successful performance and actual results have made it possible.

See the OWEN EXHIBIT *at the Road Show* Jan. 9-13, 1928 *at* CLEVELAND

Capacity—that's the whale's ability to scoop up a huge mouthful of scattered food—and the Type "K" Owen's power to quickly gather up an overload grab in loose materials.

Special design and construction features such as one piece steel crosshead, adjustable undiminished closing power, concentration of weight low in the construction, heavy shock resisting renewable lips, grit-proof Alemite lubricated bearings, make the Type "K" Owen the leader of all rehandling buckets for speed, efficiency and long life.

Type "K" Owen Buckets have saved thousands of hours in rehandling time and even more dollars for their users.

Write us for the Owen folders explaining the important "17 Reasons."

THE OWEN BUCKET COMPANY

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OWEN CLAMSHELL BUCKETS BIGGER DAYS WORK

Owen Buckets

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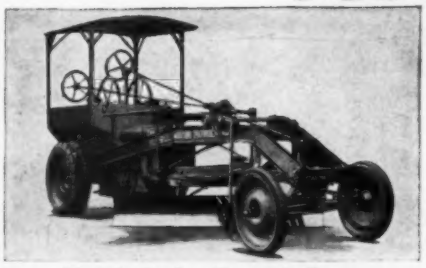
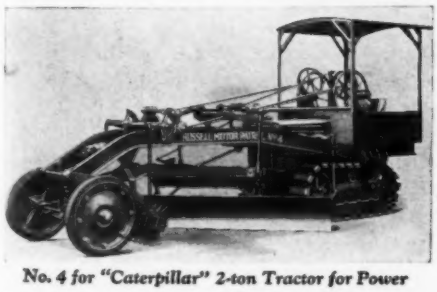


No. 2 for Fordson Tractor for Power

No. 3 for 10-20 McCormick-Deering Tractor for Power



No. 4 for "Caterpillar" 2-ton Tractor for Power

No. 5 for "Cletrac" 20-K Tractor for Power

East and West --- Jersey (69) and California (40)
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Where Road Maintenance is Most Active there RUSSELL Motor Patrols are Paramount

Actual purchases by others is convincing evidence what you may well consider for your own maintenance work—that is all we presume to suggest.

From every angle Russell Motor Patrols are proving to be the ideal maintenance equipment—sturdy and efficient with weight where it counts—speed and adaptability to actual road conditions.

With these highly finished machines comes refinement of design eliminating mere clumsy weight—machines which give speed and ease in control and a standard of efficiency which can scarcely be overestimated—then too, they afford a minimum of up-keep cost.

Here are specifically some of the dominating features—cut gears completely enclosed, Timken bearings, bronze bushings and collars for worm shafts, ball and socket connections in lifting links, tight joints, large circle for blade and long wheel base.

The complete Russell Line for Road Construction and Road Maintenance includes—

4 Sizes Motorized (Unified) Road Machines
10 Sizes Road Machines (for Horse or Tractor Power) 3 Sizes Elevating Graders

Scarifiers, Road Drags and Wheel Scrapers, Drag Lines, Conveyors, Gravel Screening, Crushing and Loading Equipment, Etc.

RUSSELL GRADER MANUFACTURING COMPANY

Factory and General Offices—
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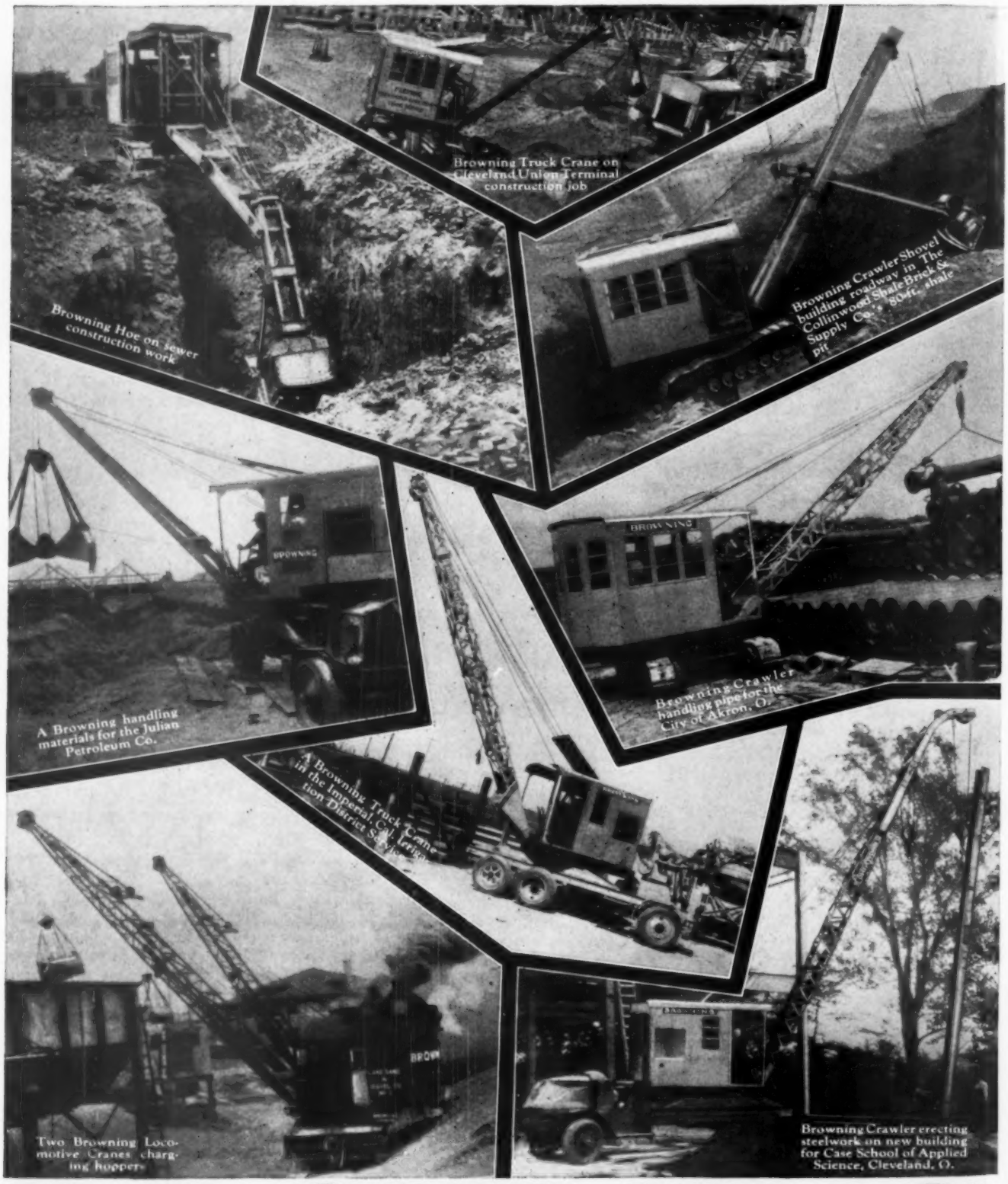
Representatives and Warehouses in all principal cities

Brownings "fit in" on every type of job!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A Browning handling materials for the Julian Petroleum Co.
BROWNING
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Two Browning Locomotive Cranes charging hoppers
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BROWNING

THE BROWNING CRANE COMPANY

16226 Waterloo Road ∴ ∴ ∴ ∴ **CLEVELAND, OHIO**

See The Browning Cranes at the 1928 Convention and Road Show, American Road Building Ass'n., January 9th to 13th Inclusive at Cleveland, Ohio.

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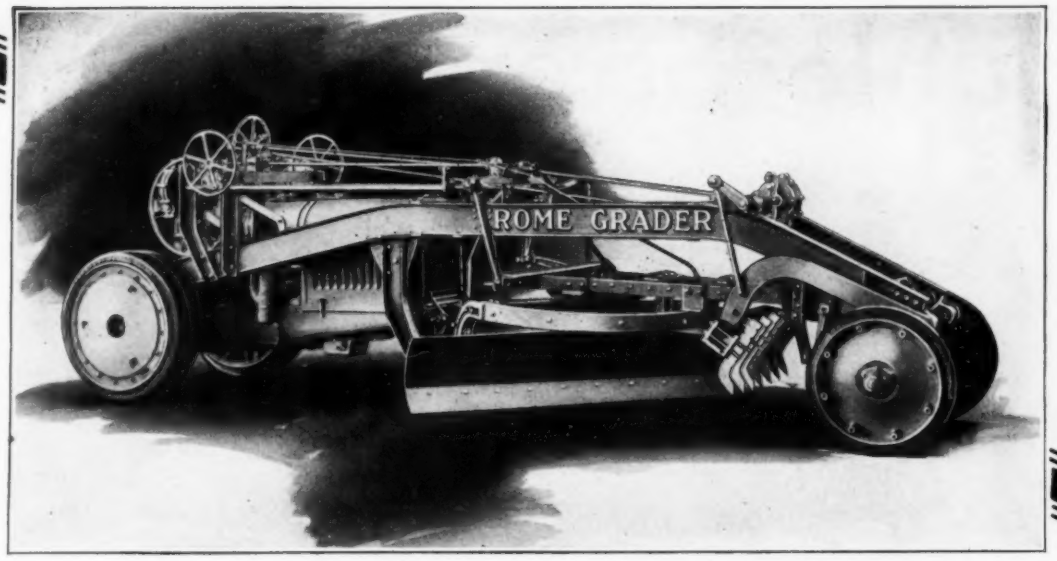

The above illustration shows an improved ROME Grader, combined with International McCormick-Deering tractor.

Announcing the New ROME *"High Lift"* Motor Grader

A Powerful, Practical Road Builder and Maintainer
Strength, Weight and Perfect Balance

The new ROME HIGH LIFT MOTOR GRADER with its many improved features, is a further advancement in the producing of better and more efficient Road Building Equipment. It carries along a step further the newer ideas that were introduced with the original ROME Grader and after further improvements, is combined with an adequate and time-tested Power unit the McCormick-Deering tractor.

ROME Motor Graders will be supplied with both regular wheel and crawler traction. Great care was exercised in designing so that the completed machine would have necessary weight so distributed as to hold to the work and still respond quickly and easily to the manipulations of the operating controls.

FRAME: Is made especially strong. The heaviest 8 in. I Beams 25½ lbs. to the foot are used.

FRONT TRUCK: Is built wide and of sufficient weight to keep the wheels down and at all times in proper steering position. Weight properly balanced at this point avoids skidding and holds the scarifier to its work.

HIGH LIFT: This patented ROME feature is retained in the motor driven machine allowing a wider range of operations than were ever before possible with a Grader of this type.

EXTRA LARGE CIRCLE: The circle of the ROME Grader is the best yet devised. It is not only immensely strong, but extra large in size. This results in that most important part of a Grader—the blade being held in its position permanently and rigidly.

SCARIFIER ATTACHMENT: Can be operated independently or in conjunction with the blade, making it possible to tear up and re-grade in a single operation.

CONTROLS: Operation is simplified and made easier by having all of these within convenient reach of the operator's platform.

TIMKEN BEARINGS & ALEMITE LUBRICATION: These contribute further toward the perfection of this new Motor Driven ROME Grader.

ECONOMY: This is a Grader for all around road work and for snow removal. Makes State, County, Township and Municipal Highway funds go the furthest.

***At the* ROAD SHOW**
in
CLEVELAND, OHIO
January 9th-14th this ROME Motor Grader will be displayed, along with other items of the ROME line.
Visit
CENTRAL ARMORY
SPACE A-Y-31

LOCOMOTIVE DEPT.

ROME MANUFACTURING COMPANY
ROME, NEW YORK **Dept. No. 4**

ROME MOTOR GRADERS
WITH THE PATENTED "HIGH LIFT"

Double Strength

Add to Your Own Experience, the Experience of Other Engineers and Contractors on Every Kind of Civil Engineering and Construction Job, as Condensed in This Library.

$29 worth of
Summarized experience to aid you daily in your work, for
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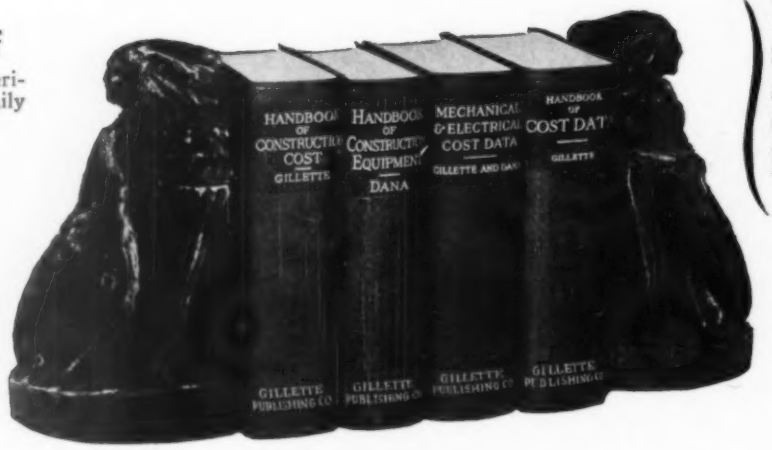

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You Can Lower Your Costs

By Comparing Your Methods With Those of Others Described in These Books

No man likes to stand alone. His safest reliance is on knowledge of the experience others have gained in his work. The Methods and Costs Library is a sure help for those engaged in practical civil engineering and construction work. Not only does it give you the methods by which other jobs were handled, but also the facts, prices, costs, time tabulations, material quantities and formula. With this concentrated data ready at hand for reference any time, you will be twice as strong and steady in your progress. Your own experience will be given *double strength* as you forge ahead in your field. These books would be worth as much to you if they cost ten times their price, or were twice as hard to get. But you can put your hands on them simply by mailing a coupon.

Also—FREE—if you act now:

An additional volume, a standard work on its subject, Gillette and Dana's Cost Keeping and Management, comes to you absolutely free of charge with this offer.

Some of the subjects covered:

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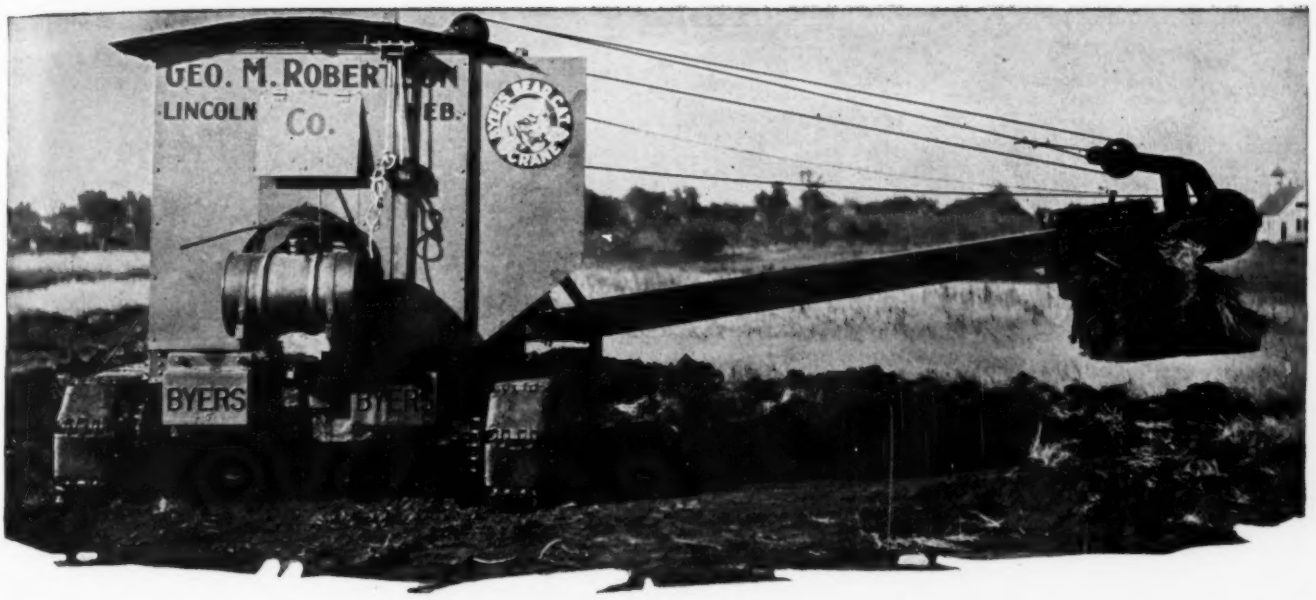
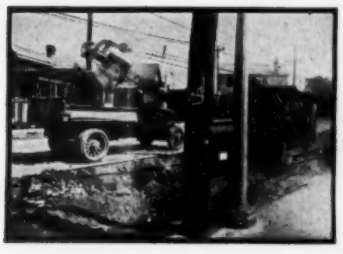
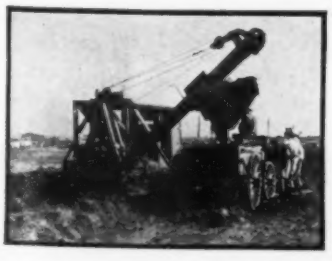


No Other Method

that equals this for shallow grading





ON street and road grading from coast to coast, the Bear Cat Skimmers have won a place all their own, based upon profitable operation. The Skimmer is a specialized machine designed to do this particular kind of work, at which the regular type of shovel is at best a makeshift.

Look at this line-up of Bear Cat features:

Straight horizontal crowd forward or side.

Quick moving up.

Speed in crowd, swing and hoist.

Low operating cost—strictly one man operation.

High grade steel construction for durability.

Five interchangeable attachments.

The Bear Cat is the most machine you can buy for the money. Let us prove it.

BYERS MACHINE COMPANY, Ravenna, Ohio

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BYERS BEAR CAT

THE ALL-PURPOSE ONE-MAN SHOVEL-CRANE

HALF-CIRCLE OR FULL-CIRCLE SWING

Gentlemen:—
Please send me information about the BEAR CAT. The kind of work I am interested in is.....
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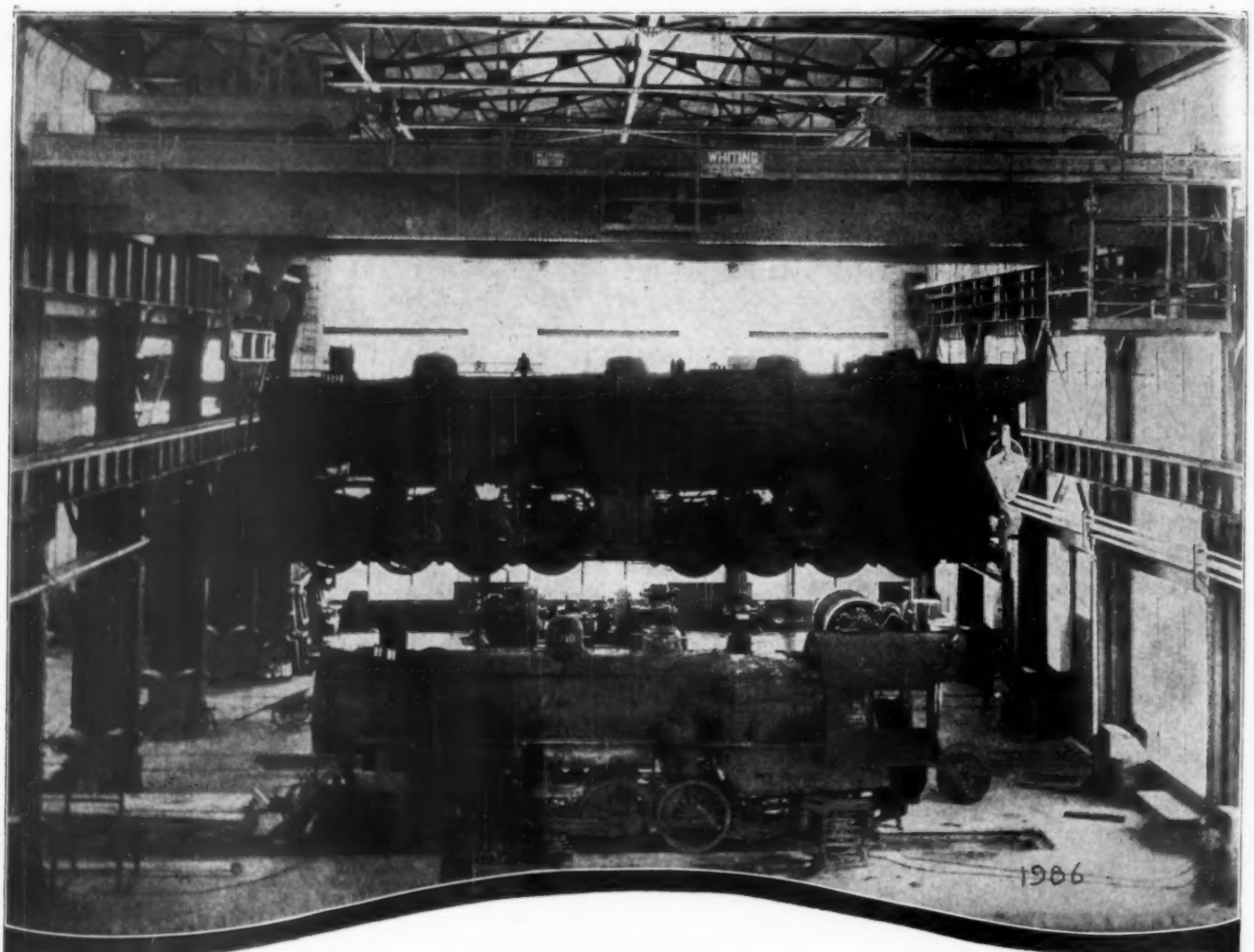

WHITING CRANES
WILLIAMSPORT WIRE ROPE

There's a combination that leaves no room for doubt about quality.

We have steadfastly maintained that where a manufacturer uses *known* quality—accessories that are accepted by the user as of the highest grade such as Williamsport Wire Rope—you have a right to feel a sense of security in your selection of the entire unit.

Williamsport Wire Ropes are Good Ropes—as good as ropes can be made. If we could tell you *how* we make them in this story you'd agree with us. We are proud of our product—that's why we weave our name into them.

When you see the Telfax Tape in the hemp core, it's a factory certification of the grade and is printed there in *plain* English. If you don't see it, you have a right to feel that you may not be getting your money's worth. You may be—but there's room for reasonable doubt;

Eliminate this doubt by insisting upon Williamsport. Play safe; you'll find Williamsport in nearly all high class equipment.

You'll not likely find it on equipment where the maker is "cutting corners" on price, because Williamsport is not a cheap rope.

It can't be—It isn't made "cheap."

WILLIAMSPORT WIRE ROPE COMPANY

Main Office and Works:
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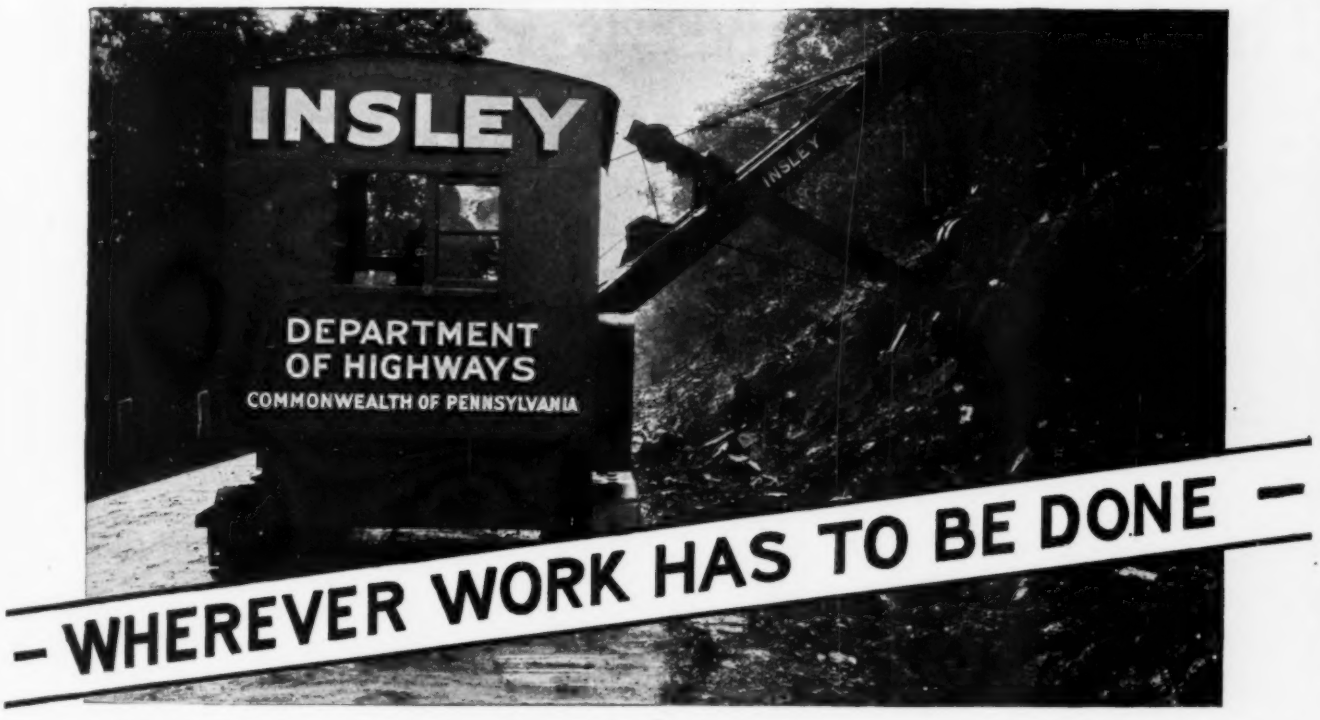
Use Madesco Tackle Blocks—They Stand the Gaff

THE INSLEY EXCAVATOR

for SHOVEL · DITCHER · CRANE
SKIMMER AND DRAGLINE WORK



Highway Department Recognition

THE Department of Highways of the Commonwealth of Pennsylvania have an Insley Excavator. Recognition from such a source proves that the Insley is generally considered of unusual value for specific purposes in highway maintenance, which consideration is borne out by the fact that many other state highway departments, among which are Ohio, California and Oregon, own and operate Insleys, as well as innumerable counties, townships, cities and other bodies having charge of road maintenance.

What is good for the highway department is also good for the contractor who does work for the highway department. Speed and ease of handling, ample power, rugged sturdiness, economy of operation and low first cost make the Insley invaluable for road and street work, highway maintenance, ditching, bridge abutment excavation, and a dozen other jobs which confront you during the average season.

DITCHER

SKIMMER

DRAGLINE

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INSLEY MANUFACTURING COMPANY • Indianapolis

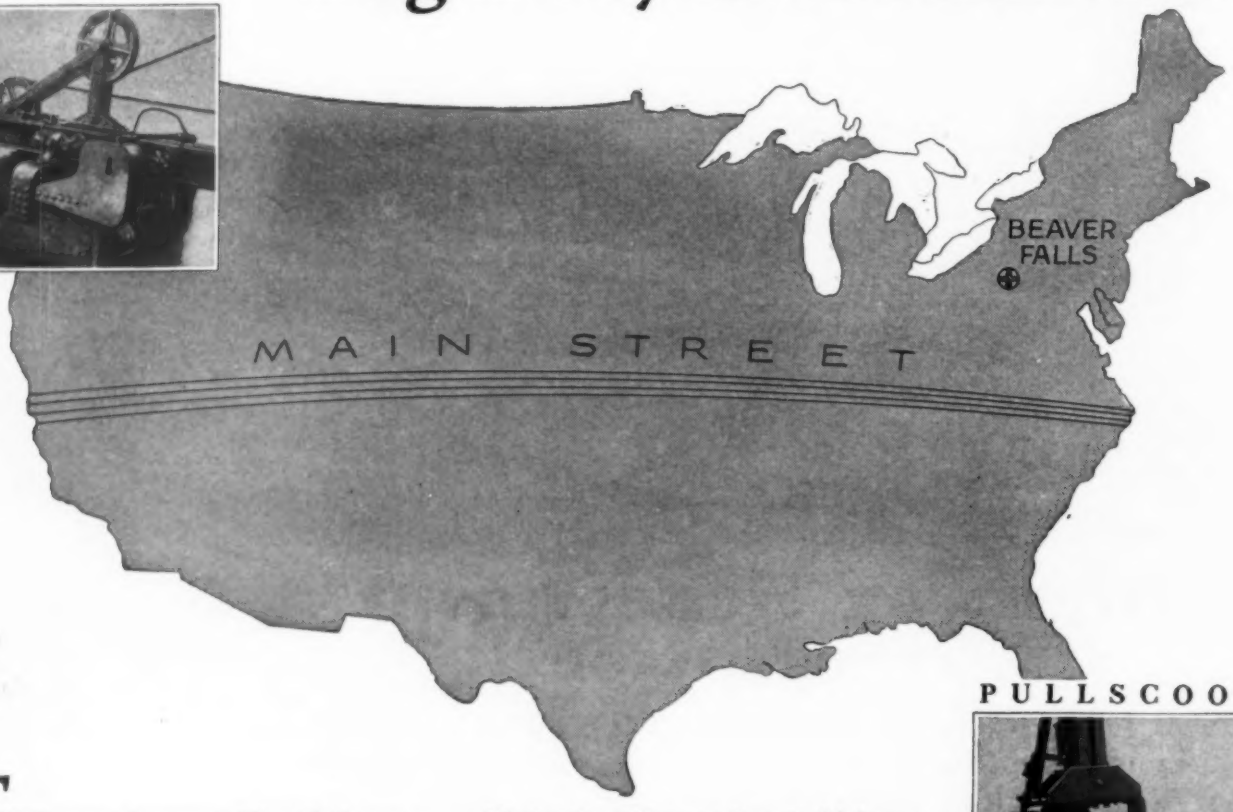
Engineers and Manufacturers

WAY BACK IN 1912

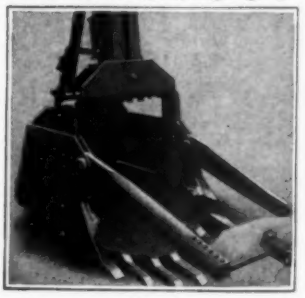
The First SKIMMER-PULLSCOOP

Dug its way down Main Street

SKIMMER



PULLSCOOP



THE street is paved. The ditches are dug. The sewers and water mains are serving a thousand towns.

* * *

And the Keystone Excavator continues its leadership in design and manufacture of a type of shovel that has won the confidence of contractors and engineers.

Fifteen years of gruelling service, experimentation, and constant betterment of design and manufacturing practice have gone into its development.

All street grading and most highway excavation are Skimmer work. The Keystone offers 14-foot horizontal crowding movement — and perfect control, insuring a closely cut grade.

All ditching and a great proportion of cellar digging, where rock or boulders are encountered, are Pullscoop jobs. The Keystone is built for them.

It is an interesting story — and a profitable one to hear. May we bring it more directly to your consideration?

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170 Broadway, New York City; Monadnock Block, Chicago, Ill.; Joplin, Mo.

KEYSTONE DRILLER COMPANY, BEAVER FALLS, PENNA.

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KEYSTONE

SKIMMER PULLSCOOP

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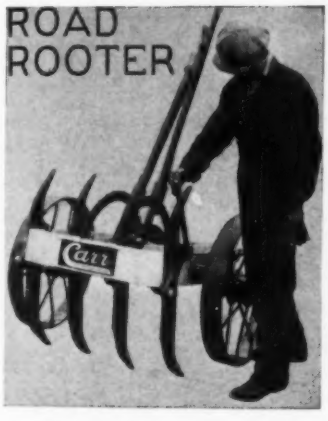
CARR Machines for Subgrading

First set your road forms on solid ground REVOLVING CUTTER takes the place of many picks and shovels on the 10,560 feet of form trench in each mile of road.

← The Wheel Rolls the Soft Spots

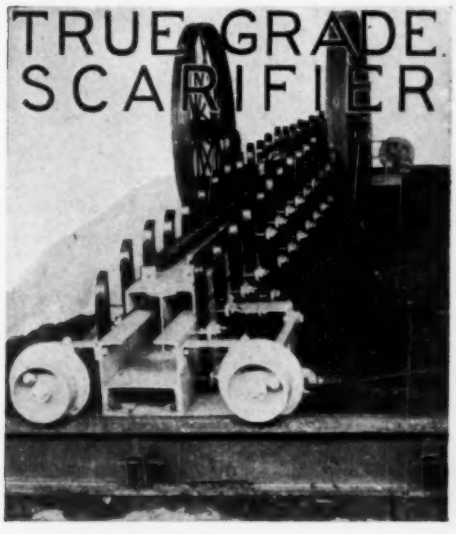


TRACTOR PLOW

A Little Devil
It's a tearer for its size

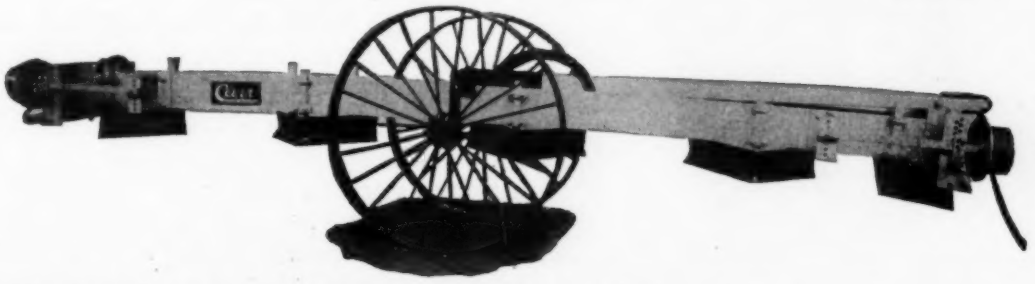
CLEAN UP BLADE

Automatically saves money
Engineer's Scratch Templates in combination or separate



A POWERFUL BRUTE

for the Hardest Subgrades
Contractor's Scratch Template that will scratch the high spots off



STEEL TRUE-GRADE PLANER. Requires only Half the Power.
Cuts half of the surface coming, and the other half going.
MR. ENGINEER:—What does a high spot on the subgrade mean? ? ?
MR. CONTRACTOR:—What does a low subgrade cost? ? ?

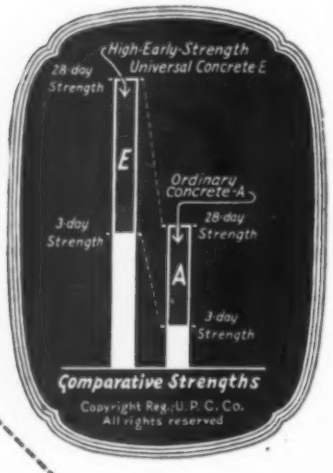
Write for the Dope

Ted Carr & Co.
E. G. CARR OWNER
939 NORTH AV. CHICAGO, ILL.

"Traffic Must Not Be Interrupted"

Said the Officials

And This Is How the Contractor Responded



Paving of Ingram Avenue, Pittsburgh, reached Duncan Street just as that thorofare was scheduled to receive "detour" traffic from another important highway. City officials declared that this traffic must not be interrupted and that Ingram Avenue must be completed without interfering with Duncan Street.

McLaughlin Contracting Co., Pittsburgh, contractor, solved the problem by using *High-Early-Strength* Universal Concrete.

At 3 *days* the concrete was stronger than ordinary concrete at 28 *days*. At 5 *days* it exceeded the requirements and was opened to traffic. At 7 *days* it was more than twice as strong as ordinary concrete at 28 *days*. In addition to the higher *early* strength, this concrete has a higher *ultimate* strength, and is therefore *permanently* better and stronger concrete. (See diagram.)

High-Early-Strength Universal Concrete can be used on all types of jobs. It is made by using fully tested methods with the usual labor, usual materials, usual equipment and usual Universal cement. For full details send in the accompanying coupon.

Name .....

Address .....

UNIVERSAL PORTLAND CEMENT CO.
210 South La Salle Street, Chicago
Without obligation, please send me detailed information on methods of securing strong concrete in 3 days with the usual materials and equipment.

R S 12-27

Universal Portland Cement Co.

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Concrete for Permanence

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Join up for '28—

Highway officials who used Barrett materials and service in 1927 will tell you that:

Barrett field men render efficient and unobtrusive assistance in planning and carrying out road building programs.

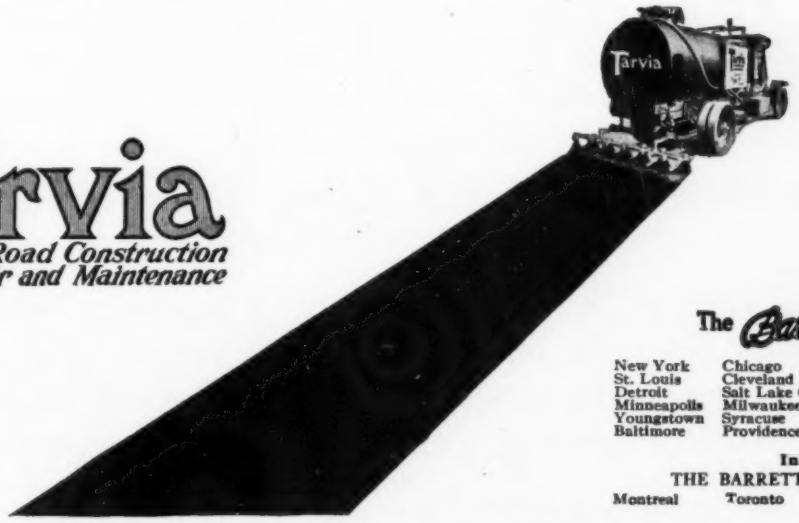
Tarvia deliveries are made by Barrett—where, when and as wanted.

Tarvia is applied from Barrett equipment by specially trained Barrett men—the whole operation supervised by expert Barrett field men.

In brief—The Barrett Company sells more than road building materials—it sells *results.*

We'd like to work with you in '28. Let's talk it over. A post-card will bring the Tarvia field man.

Tarvia
For Road Construction Repair and Maintenance



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Calls for Bids

OFFICIAL PROPOSALS

COPY for official proposals reaching our 221 E. 20th St., Chicago office on the 5th, 15th, and 25th of the month can usually be printed in the magazine issued 5 days later.

Rate: 50 cents a line an insertion

PENNSYLVANIA DEPARTMENT OF HIGHWAYS, Harrisburg, Pennsylvania. Bids will be received December 16, 1927, for construction of ten projects, totaling approximately twenty-two miles, construction to be reinforced concrete, bituminous surface treated macadam and grading and drainage. Projects situated in the following countries:

Berks	Lebanon
Blair and Huntingdon	Mercer
Clearfield	Monroe
Crawford	Westmoreland

Full particulars upon application to James L. Stuart, Secretary of Highways, Harrisburg, Pennsylvania.

Keep Posted on the latest improvements in your field by reading the advertisements that appear in our columns.

ECONOMY

—minimum upkeep and absolute safety of operation make the Hercules-Ditwiler Saftee steel dump body the ideal dumping unit.

DITWILER MFG. COMPANY

Galion, Ohio

Manufacturers of

HERCULES

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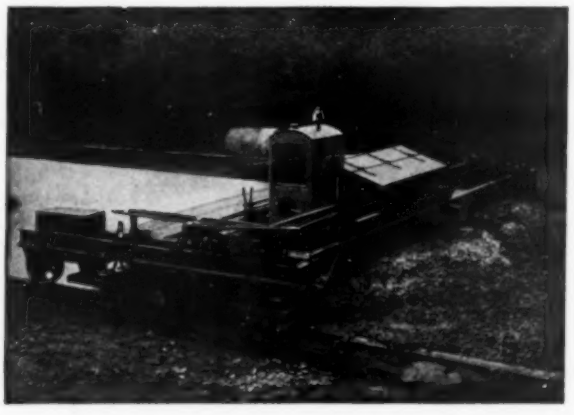
HAND HOIST STEEL DUMP Saftee AUTOMATIC BODIES

Why Worry? Use an ORD Concrete Road Finisher



Worry in road building becomes a thing of the past with an ORD on the job. You'll experience no delays, no breakdowns nor friction in getting the final O. K. from the road inspectors.

You can use the ORD for roads from 9 feet wide to 30 feet wide, for finishing the full width, for half the road or for adding a strip to an already existing road.

See Our Big Exhibit at the Road Show Cleveland, Ohio, January 9th to 13th. Space WW44.

A. W. FRENCH & CO.

Manufacturers of the ORD Concrete Road Finisher

8440 Lowe Ave. Chicago, Ill.

Make the Clearing House Show a Profit on Your Job

Often the difference between a fair profit and a large one on a construction job lies in the prompt disposal of part or all of the equipment. Our Clearing House section is read by several thousand prospective purchasers of engineering and contracting equipment.

INVESTIGATE BUTLER BINS

WHEN you're ready to buy new bin equipment you can't afford to overlook the savings that Butler Equipment can make.

Butler Bins are fast to operate, easy to load and they have ample headroom for trucks and batch cars.

They're easy to transport from one job to another and quick to dismantle or set up.

There are no cast parts to break—there's no waiting for repairs from the factory in case of accidental damage. Just remove a few bolts and straighten the damaged part at any blacksmith shop.

Ask for our new catalog. It gives complete information on all types of Butler Bins and Measuring Hoppers.

There is a distributor in your immediate vicinity. Write for his name and address.

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THE ~~SPEED KING~~

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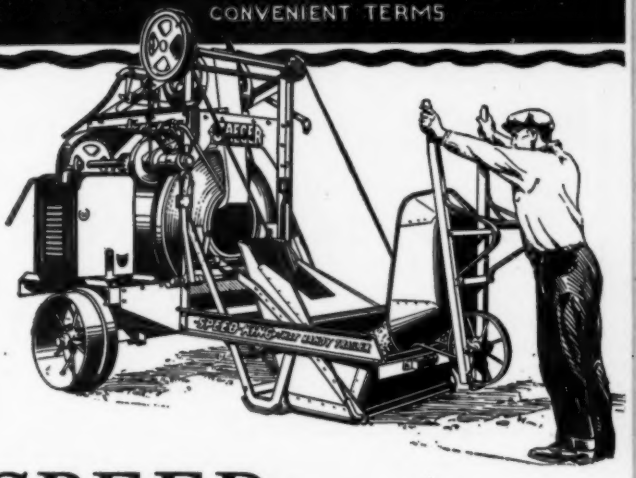

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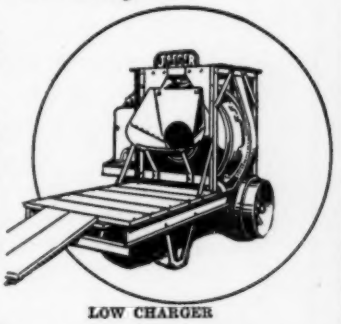
More Batches Per Day

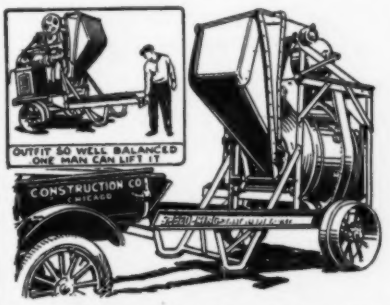
Faster discharge—fast charging without pounding using "Skip Shaker"—fast accurate measure water tank.

END DISCHARGE—Will do anything a side Discharge type will and in addition save labor and wheeling by pouring floors, walks, curbs, alleys or into forms. (Use like a Paver).

STURDIER—100% Roller bearings—steel construction cuts weight 500 lbs., adds 50% strength. More compact. A full one bag mixer.



LOW CHARGER



PORTABILITY TRAIL IT ANYWHERE

MORE PORTABLE—Trail it anywhere at high speeds—roller bearing wheels—spring shock absorbers — easy to handle, so well balanced that one man can pick up outfit like a wheelbarrow.

Jaeger Mixers furnished in all sizes 3½ ft. to 28 ft. Tilting or non-Tilt types. Write for Complete Catalog—Prices—Easy Terms.

THE JAEGER MACHINE COMPANY

223 Dublin Ave. **Columbus, Ohio**

SEND THIS SLIP TODAY FOR NEW PRICE

THE JAEGER MACHINE CO., 223 Dublin Ave., Columbus, O.,

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Name .....

Address .....

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☐ Non-Tilter (7–10–14–28 ft.) ☐ Plaster Mixer Check size wanted. ☐ Tilter (3½–5–7–10–14 ft.)

Performance Speaks Louder Than Words

So here's a little "AMERICAN GOPHER" Shovel Performance

An "AMERICAN GOPHER" Shovel on highway work in Minnesota is making a remarkable record for digging speed and endurance. Here is a thumb-nail report of one week's work:

October 17th. Worked from 6 a. m. to 6:30 p. m. loaded out 600 yards, 5 hours delay on account of no trucks, 35 gallons of gas.

October 18th. Worked from 6 a. m. to 6 p. m. loaded out 700 yards, 4 hours delay on account of no trucks, 35 gallons of gas, 2½ gallons motor oil.

October 19th. Worked from 6 a. m. to 5:30 p. m. loaded out 700 yards, 4 hours delay on account of no trucks, 35 gallons gas.

October 20th. Worked from 7 a. m. to 5:30 p. m. loaded out 760 yards, 3 hours delay on account of no trucks, 40 gallons gas.

October 21st. Worked from 7 to 5:30 p. m. loaded out 882 yards, 1 hour delay on account of no trucks, 40 gallons gas.

October 22nd. Worked from 7 a. m. to 5:30 p. m. loaded out 650 yards, 2 hours delay on account of no trucks, 40 gallons gas. Write for complete information.

Visit our booth No. WW-85 at the Road Show in Cleveland, January 9th-13th, 1928

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HOIST & DERRICK CO.
Saint Paul, Minn.
New York, Chicago, Pittsburgh, Seattle, St. Louis, New Orleans.

It costs just as much to lay inferior sewer pipe—and a lot more when it's taken up

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VITRIFIED *Salt Glazed* **CLAY**
Sanitary Sewer Pipe

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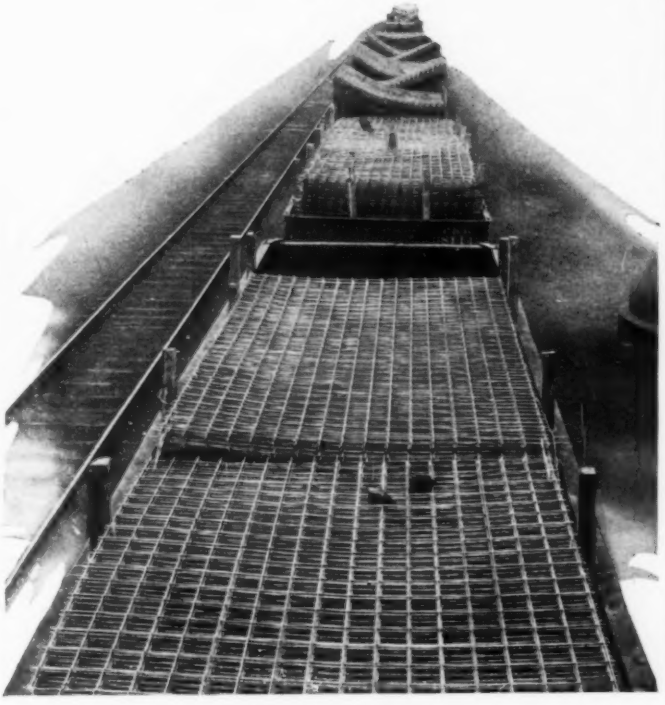
American Steel & Wire Company's

WIRE FABRIC

"The Steel Backbone for Concrete"



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Prompt Deliveries mean Profitable Contracts

THE American Steel & Wire Company with its unequaled facilities and large stocks is in position to make prompt deliveries of Wire Fabric Reinforcement.

This means profitable fulfillment of your contracts. Write or wire for quotation on current requirements.

American Steel & Wire Company

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SEE THEM

At the Road Show

Bay City 16-B Skimmer

also

Tractor Shovel and Ditcher

Skimming along

The above picture shows a Bay City 16-B with skimmer bucket, owned by the Wallin Concrete Products Co., Paving Contractors, Asbury Park, N. J., engaged in excavating and cutting down grades near Asbury Park for a new paving project.

Contractors everywhere are making good profits on jobs by using the convertible 16-B. Many think there's no machine in its class can match its performance and economy.

The Tractor Shovel is another big money maker. Send for literature on either or both.

Convertible Power Shovel

The Tractor Shovel with Trench Scoop

BAY CITY DREDGE WORKS

Power Shovels—Excavators—Dredges

New York Office
302 Broadway

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BAY-CITY

TRACTOR SHOVELS — TRENCHERS — SKIMMERS

Here is a 9-B-2 Pile Hammer driving 60-foot timber piles under water. The base of the hammer was fitted with a pipe extension, to eliminate the necessity for leads. Piles were driven 10 feet below mean low water level and by this method 52 piles were driven per 8-hour day. The contractor stated that the McKiernan-Terry method made this an easy job as compared with what it would have been if he had used pile driver leads of any kind.

DRIVING PILES UNDER WATER

The July 14th issue of Engineering News-Record contained an interesting description of a *submarine* pile driving operation in which a McKiernan-Terry Hammer was used. We quote from this article:

> "Each pier foundation contained about 1,300 piles, spaced a fraction less than 3 feet on centers. Spruce piles were used, in lengths from 20 to 35 feet with butt measurement of 12 inches and point of 6 inches. The driving was very hard, and piles were driven to practical refusal; the penetration under the last ten blows indicated a bearing power of about 30 tons. The penetration varied from 20 feet average in the west pier to 25 feet in the east pier. With seven men on the driver, about 85 piles were driven in an 8-hour shift, and the greatest number was 107.
>
> "Much better results were obtained with the submarine hammer than could have been obtained by other methods, due to the accuracy of spacing and speed of driving, as no followers or jet were required."

Many interesting pictures of submarine pile driving will be found in the new McKiernan-Terry Catalogue. Also pictures—there are *one hundred* of them all together—of all kinds of pile driving, from the heaviest to the lightest. Send for a copy of this 100-page book (on your letterhead, please).

McKiernan-Terry Drill Company

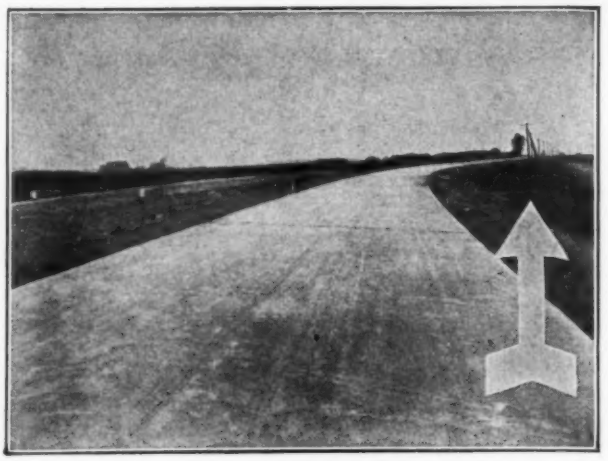
18 Park Row, New York

AGENTS IN PRINCIPAL CITIES

McKiernan-Terry

DOUBLE-ACTING RAPID-DRIVING

PILE HAMMERS



SPI-COR

for changing road conditions

Examine this picture closely. It shows graphically why the already widespread preference for Spi-Cor Culvert is rapidly increasing.

New traffic conditions dictated abandonment of old road. Concrete box culvert had no salvage value. Spi-Cor laid under new road, is 100% salvageable.

A 10-ft. strip will shortly be added to new road. New joints are added as needed.

Spi-Cor resists rust, wear and the pounding of traffic. Easy and cheap to install. Always salvageable.

SPI-COR

Cast Iron Spiral Corrugated Culvert Pipe

Get the facts for yourself. Write for full details today.

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50" PRESSED STEEL PLATE DRUM

WEIGHS 700 LBS LESS THAN OLD CAST HEAD TYPES

ENGINE PULLS THAT MUCH LESS DEAD LOAD

STEEL TRACKS NO FLAT SPOTS

HYATT ROLLER BEARINGS SAVE 17% POWER

Built of Steel

BOSS ONE~TWO BAGGER

One Bag—Any Proportion
Two Bags—1-2-5 Mix

A Sensibly Sized Mixer for Any Job

Weighs No More—Costs No More Than Some One Bag Mixers

WRITE FOR 1927 CATALOG

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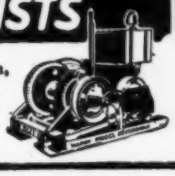
The American Cement Machine Co., Inc.
Dept. 246 Keokuk, Iowa
Branch Offices and Warehouses in all Principal Cities
See our Booth No. E. H. 43 at the Cleveland Road Show, January 9th to 13th, Inclusive.

BOSS HOISTS

Single or Double Drum, 5 to 35 Horse Power. Electric or Gasoline Engine operation.



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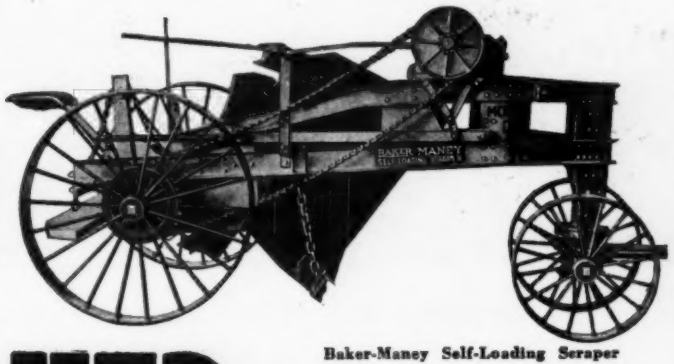
Heavy Duty Type Tilters
Low Chargers and Power Loaders
3½S - 5S - 7S - Sizes
Road Builder's Special Outfits

BOSS TrailerMixers

Drum or Tilter Types. Fast. Handy Complete with Engine. Cushion or Steel Tires. Low prices.

Baker Auto Truck Snow Plow



Baker-Maney Self-Loading Scraper

SNOW PLOWS
For Trucks and Tractors

The snow plows that have satisfied thousands in thirty-six states are made in both "V" and single blade types in new and original designs for speed, endurance and thorough results on streets and highways.

BAKER
DEPENDABLE PRODUCTS

The Baker Manufacturing Co.
506 Stanford Ave., Springfield, Ill.

MANEY SCRAPERS
Self Loading and Dumping

The original self-loading scrapers are made in both ¾ and 1¼ yard capacities for heavy duty use behind tractors either singly or in trains of two to six scrapers. Strong, short-turning and long lived.

Clip out this coupon and get complete information

The Baker Mfg. Co.
Springfield, Ill.

Maney Scrapers ☐
Snow Plows ☐

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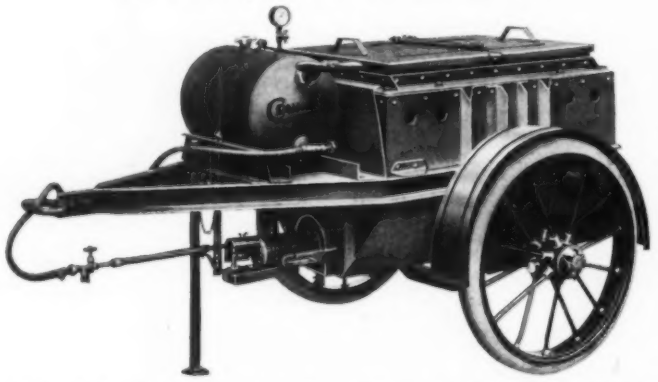
Name ..... Address .....

Connery's Tar and Asphalt Heaters

Style "J" Oil Burning

Made in 50, 75, 100 and 165 Gallons

Saves
Time
Labor
Money



No
Coking
Ashes
Sparks

The best way to find out which of the twenty styles and sizes (10 to 1,500 gallon capacities) will fill your needs is to write for our little "Blue Book" and look them all over. A glance through this booklet will show you that Connery Tar and Asphalt Heaters cover the field in design and usefulness as well.

The Style "J" Kettle shown is designed exclusively for oil as fuel. The inside tank is so constructed that the hot and cold materials are kept separate. Due to this special feature cold material may be added without lowering temperature of heated material.

The Kettle is furnished with roller bearing wheels and springs. Inside tanks are electrically welded and can be removed for cleaning. Distributing tube is furnished which prevents inside tank burning out and enables oil burner to furnish a steady and uniform heat. Solid rubber tires can be furnished, if desired, at additional cost. Oil Burner can be removed for thawing in winter, or other purposes.

CONNERY & COMPANY, INCORPORATED

3996 N. Second St., Philadelphia, Pa.

Etnyre OREGON ILL.

Illustrating the preference for Etnyre Model F Distributors

THIS group of Etnyre Model F Distributors are owned by the F. J. Lewis Mfg. Co., 2513 South Robey Street, Chicago, Illinois.

The first two were purchased in 1925. Their satisfactory performance led to another purchase of five more in 1926.

They have standardized on Etnyre Model F Distributors and use no other make.

These Etnyre Distributors are all 800 gallon capacity and are mounted on Mack trucks.

Etnyre Model F Distributors are without a peer for heating and distributing all grades of Liquid Bituminous Road Materials. 500 to 1200 gallon standard capacities. Now mounted on twenty-four different truck chassis. Low maintenance and operation cost.

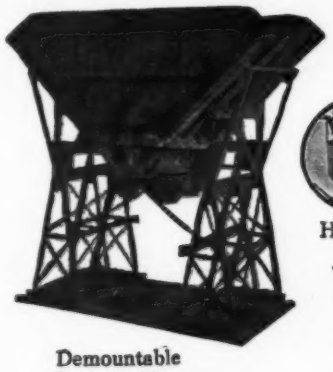
It will pay you to standardize on Etnyres. Write for Catalog No. 502.

E. D. ETNYRE & COMPANY, Inc. **61 Jefferson St., Oregon, Illinois**

Boston Office: *G. E. Pearson, Mgr.* ***11 Beacon Street***

BRANCH OFFICES IN PRINCIPAL CITIES

FLUSHERS — SPRINKLERS — OILERS



Demountable Bin with Hoppers

Hoppers for Wood Bins

Johnson Demountable Bins

The speed and ease of erecting Johnson Bins is a feature we're proud of. It cuts the costs way down and makes the profits grow. You can have one of these bins complete in 45 minutes. There isn't a section of a Johnson Bin that isn't within shipping dimensions. All section weights can be lifted by the smaller cranes. We've done everything practically possible to make this bin perfect for your needs.

—and Batch Measuring Hoppers

State Highway requirements are met in every way by Johnson Hoppers. They measure accurately. They are round, with no corners to arch. They give full discharge, are easily operated, allow visual check and dual loading. If such a hopper does not suit your purpose, send us your specifications and we'll make you a special type that does.

C. S. Johnson Company

Champaign, Ill.

"Ask Us—"

Men who are using our bins and hoppers write, saying, "Refer to us whenever you wish." If you want to know what results they are getting, we will be glad to give you names and addresses to write to.

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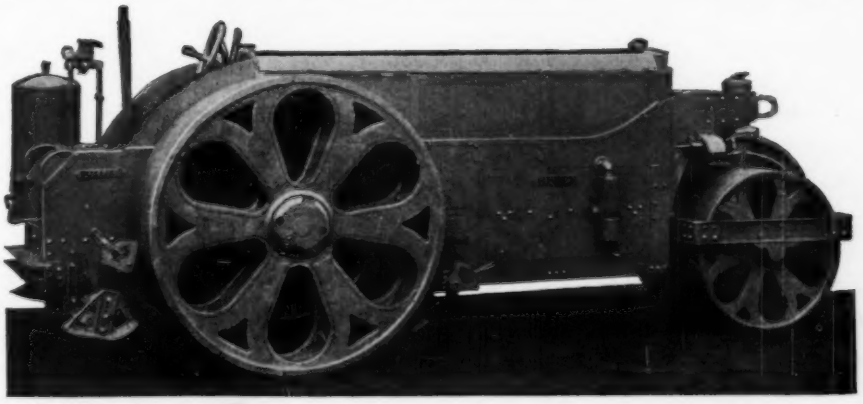
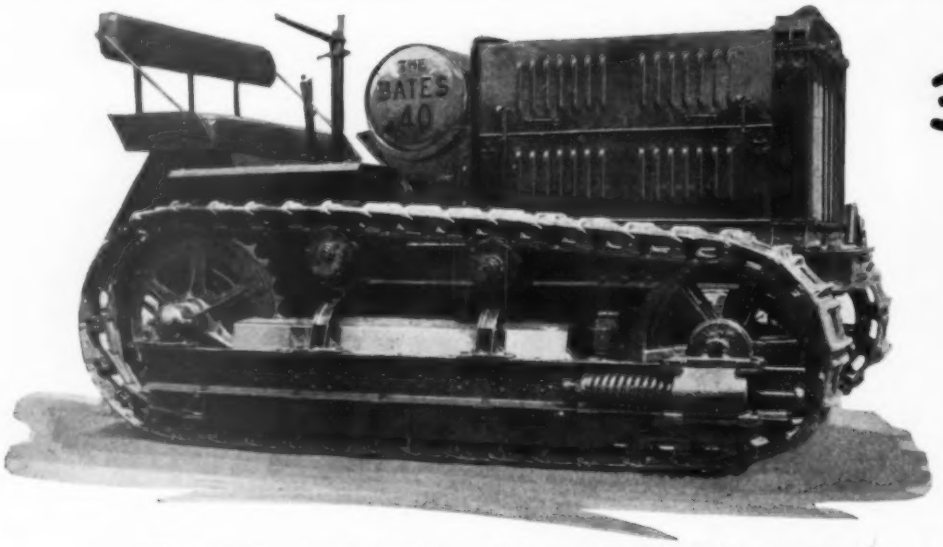
MOTOR ROLLERS

Four cylinders—four sizes (5-7-10-12 tons). Look to Huber for easy single-lever control—short turns—quick action—low up-keep—unusual dependability. The Huber is endorsed and used by leading contractors everywhere. It will be worth your while to send for free catalog giving full mechanical details.

THE HUBER MFG. CO., 350 Center St. MARION, OHIO





3 sizes

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Bates 40
Bates 70

Let us tell you what our customers say.

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"The strongest made tractor on the market," says Indiana contractor.

"Are proud of our tractor, spent less than $10.00 for repairs in three years," says Illinois Highway Superintendent.

"Get very good service with our Bates," says one of the largest oil companies in the world.

"Our Bates tractor beats them all and the Bates people are sure fine to deal with," says Illinois contractor.

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Established 1883

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Save Time, Money, Labor, Detour Maintenance, Road Repair; Road Maintenance

Fourteen days saved! Fourteen more days' use from new roads! Fourteen days of detouring, of detour maintenance—thousands of traffic miles, hours and hours of time and energy, countless dollars—*Saved* by less than 4 cents worth of 3 C 75% Flake Calcium Chloride per 100 lbs. of cement! And think of the new winter construction and the invaluable winter repair and maintenance it makes possible! And if 3 C Flake Calcium Choride saved only winter time, it would be invaluable. No skilled labor required. The cost to apply is very low—less than the average cover method.

All Calcium Chloride sold by us is manufactured by our Principals, the Pittsburgh Plate Glass Company, Columbia Chemical Division, at Barberton, Ohio.

Booklet sent on request

Carbondale Calcium Co.
Carbondale, Pa.

Calcium 3 Chloride

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The RYAN Moves More Dirt With Less Power

— because of its leanable frame and perfect blade positions

Motor Control

Easy and speedy adjustment to all positions—permitting the operator to attain far greater efficiency.

Leanable Frame

Shifts weight of machine against load—prevents skidding and lightens pull.

New Blade Positions

Makes high bank cutting easy—gives perfect blade setting for any work, moving more dirt with less power.

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Motor Controlled Leanable Frame **GRADING MACHINE**

"More than a grader"

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The Most Important Thing In Laying Concrete

Western Heavy Duty Truck, with brake

Is to keep the mixer in continuous production. Every delay reduces profits. The Western Heavy Duty Road Builders' truck has the strength that insures continuous and uninterrupted delivery of material to the mixer.

It eliminates delays chargeable to your haulage equipment.

The intimate knowledge and experience of our engineers in the use of industrial haulage equipment for concrete road construction is yours for the asking.

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WESTERN WHEELED SCRAPER COMPANY

Dump Cars and Grading Equipment

AURORA :: ILLINOIS

Now is the time to

Stop Constant Replanking of Your Wooden Bridge Floors

Right now—while your thoughts are centered on the annoyance of rattle and chatter of loose planks and the expense of replanking bridge floors—make your decision to install "A. W." Traffic Treads directly over the lines of traffic wear.

"A. W." Traffic Treads over lines of concentrated wheel travel on wooden floor bridges (old or new) offer a solution to Highway Officials and Engineers everywhere, in combating the wear and tear of modern vehicular traffic.

"A. W." Traffic Treads are economical to install; practically without maintenance cost; don't break like cast iron and prolong the life of the bridge.

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Visit our exhibit EH-71 at the Good Roads Show, Cleveland, Jan. 9-13, 1928

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"For Smooth operation this boom is without an equal"

Type "R" owned by Mariemont Company, handling trench excavation and laying concrete sewer pipe.

When you watch the Bay City "R" Crane swing smoothly in operation, and the boom raise and lower without the slightest jerk or wobble, you'll understand why we get letters like this:

"In handling some materials, it is a prime necessity that the hoisting, holding and lowering mechanism function with the greatest degree of smoothness possible. And the Bay City fills the bill. We know of no other boom that will work more smoothly."—(Name on request).

On all kinds of rehandling or excavating—you have smooth operation that means a bigger day's work—less cost for repairs and fuel.

Write for our folder showing how you can make more money with this smoother, faster crane.

BAY CITY FOUNDRY & MACHINE CO.
BAY CITY, MICHIGAN

Bay City Full revolving Motor Truck Cranes

DO YOU WANT SPEED? UNIVERSALS HAVE IT!

Universals run from job to job at truck speed. Over city streets, through heavy traffic, Universals "roll" right along at 10, 15, 20 miles per hour.

Universals combine motor truck mobility with crane earning power—let us tell you what this means in eliminating moving cost — and in getting more jobs and bigger profits.

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Vertical Blue Print File.

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THE SUPER BLUE PRINT FILE

For efficient filing of sets of plans. This device has been on the proving grounds of actual use, in Architect's and Engineer's offices for years, and unanimously endorsed. Previously, filing sets of plans was a real problem; now it is very simple. The Calumet has large capacity in a minimum of space. : : : : : :

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Hamilton Mfg. Co., Two Rivers, Wis.
Send me booklet B-3- R&S on the Calumet File.

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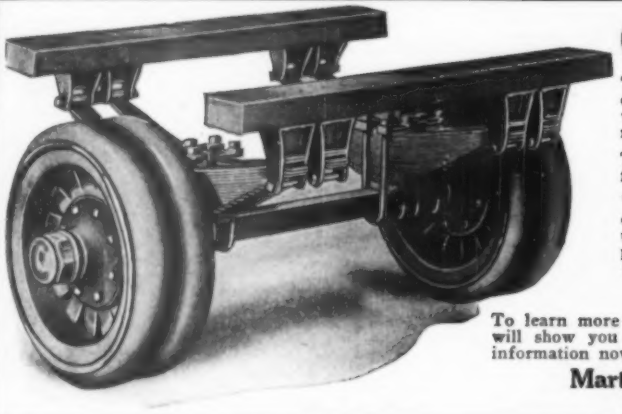
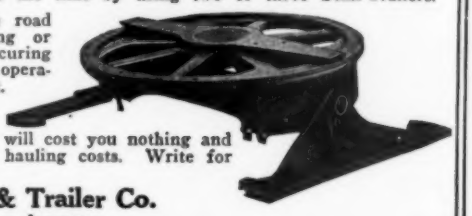


Carry Twice the Load of a Truck

The Martin Semi-Trailer together with the Martin Rocking Fifth Wheel double and in many cases treble the carrying capacity of a motor truck without proportionately increasing the original cost of equipment or the running expense.

The Martin Rocking Fifth Wheel and Semi-Trailer can be kept busy from 85% to 95% of the time by using two or three Semi-Trailers.

While one is on the road others can be loading or unloading, thereby securing practically continuous operation of the motor unit.



To learn more about this equipment will cost you nothing and will show you how to reduce your hauling costs. Write for information now.

Martin Fifth Wheel & Trailer Co.
Easthampton, Massachusetts

HERE'S a great little cooperator — the Iron Mule. Works in perfect harmony with any kind of grading or road building machinery. Iron-Mule is the original 2 yard Tractor Dump —powerful, efficient, economical. Pays its way and pays a profit on any job you ask it to do.

Hundreds of Iron Mules are giving astonishing service in street and road work. See your nearest Fordson dealer or write—

The HUGHES-KEENAN CO., Mansfield, Ohio

HUGHES-KEENAN
Steel Dump Bodies

The Machine Road Builders Have Awaited

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CONCRETE HIGHWAY SURFACER

A One-Man Machine

The BERG—powered by an air-cooled gas engine—has revolutionized concrete highway surfacing. Cuts down surface irregularities, uneven expansion joints and repaired patches to billiard-table smoothness. Does the work of ten men at one-tenth the cost. Eliminates expensive outfits, tools, high operating costs, large crews.

Write now for complete information!

The Concrete Surfacing Mach'y Co.
Pioneer Makers of Machines for All Kinds of Concrete Surfacing
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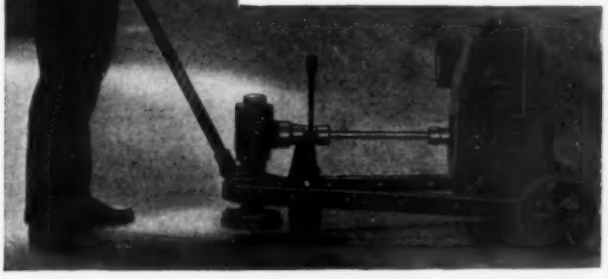


The BERG in use on the New Wilmington Road, running eastward out of New Castle, Pa.

Do Your Digging and Material Handling with a

Kiesler Clam Shell Bucket

The Kiesler Bucket is an all-purpose Bucket. It will dig, unload cars or rehandle material expeditiously. It is adapted for crushed stone, clay, sand, coal, cinders, Kentucky rock asphalt, dredging or excavating, and for all general purposes.

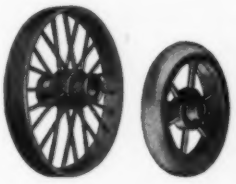
The Kiesler Patent Clam Shell Bucket is the original and only clam shell bucket operated on the Double-Lever-Arm principle.

They are constructed to withstand hard service, and the shells cannot get out of alignment as they are doubly reinforced.

If you want to know more about Kiesler Buckets, write us for literature.

JOS. F. KIESLER COMPANY
932 West Huron Street, Chicago, Ill.

Wheels, Axles, Trucks, Special Mountings



For all kinds of Portable Machinery, Contractors' Equipment, Engines, Hoists, Concrete Mixers, Pumps, Compressors, Crushers, etc. Either horse drawn or self-propelling. Wheels either steel or rubber tire and continuous treads.

Our engineering service includes a thorough study of the customer's requirements with suggestions as to the best type of mounting for each machine.

Ask for Bulletins, giving description of machine.

Visit our exhibit at the Road Show, Chicago, January 10th to 14th, 1927

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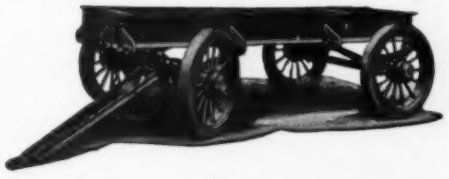

Hayward Buckets

Watch a Hayward in Action

Watch a Hayward in action. Watch it sink its jaws into a pile of material, and bite for itself an over capacity load time and time again. Note the speed with which it opens and closes. See how *sure* the action is.

Talk things over with a Hayward engineer. A consultation costs nothing.

THE HAYWARD CO.
38-50 Church Street
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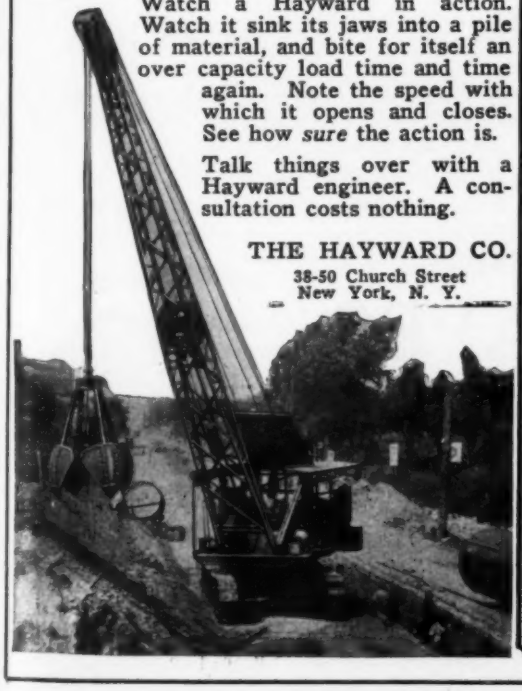


3670-Y

Sauerman Power Drag Scraper Cutting Off Top of Hill and Making a Fill 200 Feet Long Across a Ravine.

Making the Invested Dollar Bring in More Revenue

YOU can turn from one excavating job to another—can make cuts and fills—can strip overburden—can load gravel direct from the pit—can grade the roughest of land—can store and reclaim concrete aggregates—and can handle all kinds of dirt handling jobs at a low cost per yard with a Sauerman Power Drag Scraper.

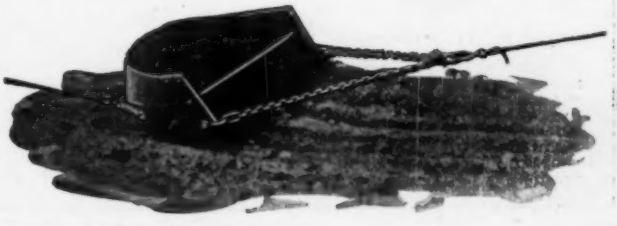
A Sauerman "Crescent" Power Drag Scraper has the penetrating power necessary for working in hard-packed gravel or clay. It digs straight and level, "floats" its load over the ground, and in dumping makes a clean, instantaneous discharge, even when its contents are sticky.

A Sauerman Power Drag Scraper has a working range of from 100 to 600 feet or more and can handle from 10 to 400 cu. yds. of material per hour; the handling capacity depending upon the material, the working span, and the size of the scraper.

If you are interested in making your invested dollar bring in a greater revenue—more of which is profit—write us about the work you have under way or are contemplating. In the meantime send for Pamphlet No. 24.

SAUERMAN BROS., Inc.

488 South Clinton Street **CHICAGO**



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STEAM AND MOTOR ROLLERS

The choice of experienced users.
Made in all types and weights.

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PORTABLE CRUSHERS

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ALSO
ROLL CRUSHERS,
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Complete plants installed for
Sand - Stone - Gravel or Cinder

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We ship Illinois Standard Cast Iron Bridge Rockers and Steel Plates from stock.

Special size Rockers, Plates and Structural Steel Expansion Devices made and shipped quickly.

BRONZE MEMORIAL TABLETS AND BRIDGE NAME PLATES

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QUALITY AND SERVICE

EGYPTIAN IRON WORKS

425 South 17th Street
MURPHYSBORO, ILLINOIS

Two Sturdy and Reliable

LUFKIN TAPES

For the Road Builder

In addition to these we make tapes of styles and grades suited to every class of your work, also

SPRING JOINT WOOD RULES
BOXWOOD AND STEEL RULES

Send for Catalogue

THE LUFKIN RULE CO.
SAGINAW, MICH.
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ENGINEERS PATTERN

Popular with the engineers. A ⅛-inch wide extra heavy steel tape in substantial metal-lined leather case. Also furnished in open disc reel and open metal frame.

THE "CHALLENGE"

Suitable for any measuring. A steel line in high-grade metal-lined leather case. Made with ⅜ and ½-inch wide line. Many highway departments prefer the ½-in. and we recommend it for heavy service.

Thor
PORTABLE AIR COMPRESSORS

The THOR is direct-driven. It has no clutch, no coupling, no gears. It is the simplest unit made and the most powerful of its size on the market. And the Rix Super-charger, an exclusive, patented feature, makes it the most efficient. Get the complete story of the compressor that has established a new standard of efficiency.

Write for facts—they will surprise you.

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PNEUMATIC TOOLS — GENERAL OFFICES 600 W. Jackson Blvd. CHICAGO — ELECTRIC TOOLS

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Allis-Chalmers 18-Inch Superior McCully Fine Reduction Gyratory Crusher

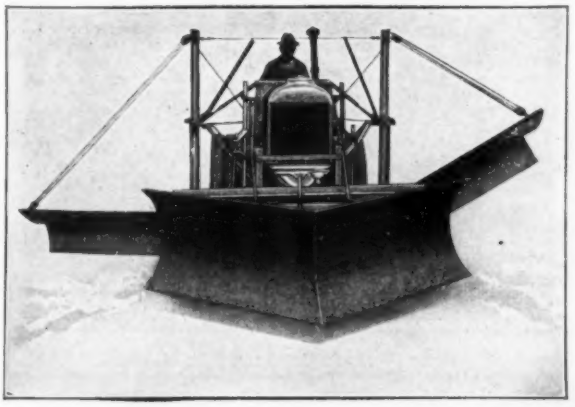
The latest development in the Superior McCully Fine Reduction line, furnished to a large Cement Company—having two feed openings, each 18 in. by 68 in.—capable of taking the product from the largest size primary crushers — capacity with minimum discharge opening of 2½ in.—225 to 275 tons per hour.

The 18-in. Crusher incorporates all the features which have contributed so largely to the wonderful success of the smaller sizes of this type.

ALLIS-CHALMERS MANUFACTURING COMPANY

MILWAUKEE, WISCONSIN. U.S.A.

Acme Snow Handler



A light yet powerful snow handler powered with either Fordson or McCormick-Deering tractor power plants.

Gear Reduction to independent axle and locking device for differential.

Rigid steel frame relieves tractor of all stress. "V" Blade ahead, main blade and wings in center. Short wheel base and low center of gravity.

Scarifier in rear for breaking ice and removing ruts.

Write for Bulletin No. 126.

Acme Road Machinery Company, Inc.,
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A QUARTER CENTURY OF EXPERIENCE

If you have a dumping problem!

Wood Dumping equipment is the Answer. Wood builds hoists and bodies for every purpose.

Hydraulic Hoists—3 Types

Mechanical Hoists
Hi-Lift Hoists
Self Dumping Hoists
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12 standard designs, special bodies built to order when specified

Meet us at the Good Roads Show, Cleveland, January 9th-13th

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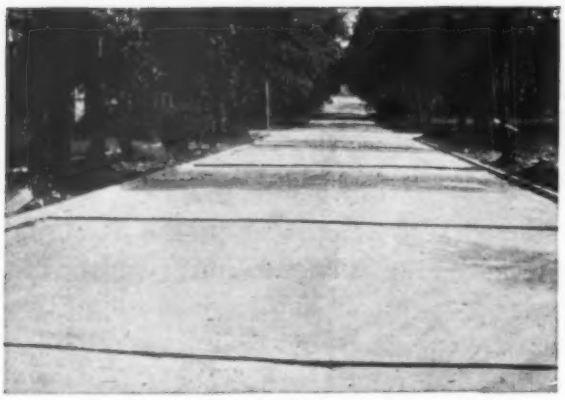
Wood Hydraulic Hoist & Body Co.

World's Largest Builder of Dumping Equipment

Detroit, U. S. A.

WOOD HOISTS-BODIES



Permanent Protection Against
CRUSHING and SPALLING

SEALTIGHT

THE PERFECTED JOINT

When you install Sealtight Expansion Joints, they're there to stay as permanent protection against crushing, spalling and general deterioration of the road. Sealtight stays in the joint—does not run out at the top.

Sealtight is made of high grade pure blown petroleum asphalt and a long flexible vegetable fibre filler.

It adheres to the sides of the slabs, sealing the joint perfectly against the entrance of water, sand and pebbles. Because of the special quality fibre filler, Sealtight does not shatter when handled in winter nor bend out of shape in summer.

Make the Road Right—Use "Sealtight"

W. R. MEADOWS, Inc. :: Elgin, Ill.

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Saves You Money

It salvages a large amount of cement from every empty cement sack. It saves the freight on this cement sent back to the cement mills. Clean sacks receive better credit than dirty ones. Saves labor in baling. No foreign sacks in your shipments. The above results save you money. Write us for prices and further information today.

THE HANDY SACK BALER CO., Marion, Iowa

The Most Universally Used Cleaner in the United States

"TIGER" STEEL BUNKS

Give your men clean, comfortable beds to sleep in and they will do better work. "Tiger" Steel Bunks are of durable and sanitary construction. Frame is steel coated with rustproof enamel. The wire link fabric springs are attached to the frame with oil tempered helical springs which assure elasticity and are a guarantee against sagging. Easily knocked down for shipping. Require very little space. Made in single or double decks in a wide range of sizes.

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USE AEROIL HEATING AND THAWING EQUIPMENT

Concrete Heaters	"Smokeless" Salamanders
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62 Years of Reputation

Wherever Precision is Demanded — You Will Find a

BUFF

Buff Instruments are used almost exclusively on large work everywhere. Remember this when selecting your instruments.

Your request brings the Buff Catalog No. 27

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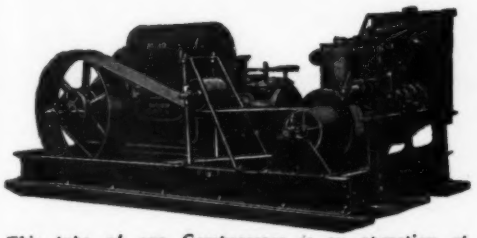
ZIN-HO Compressors Are Built *RIGHT*



This type of our Compressors is in operation at Starved Rock Dam, Illinois Deep Waterway Project, Utica, Illinois. Capacity 423 cu. ft. of air per minute.

We build both Belt Driven and Direct Driven units. Our Direct Driven units are equipped with the latest and most approved type of flexible couplings, which absorb the shock caused by the action of the unloader of the Compressor. A separate Radiator for both Engine and Compressor on all of our Belt Driven units is a special feature.

All sizes and types of our Compressors can be mounted on Solid Rubber Tire Spring Trailer Trucks or on Rubber Tired Wheels. All types can be Semi-Portable mounted, on skids. Built in sizes from 9 cu. ft. to 954 cu. ft. capacities and Gasoline Engine and Electric Motor driven.

Particular attention is paid to building a rugged, stoutly constructed, properly aligned, dependable and economical Compressor plant. All of our machines are ready to operate when shipped.

For complete information, write

THE MUNDIE MANUFACTURING COMPANY

501-631 Brunner Street, Peru, Illinois, U. S. A.

Specialty Engineering Co.

FORDSON LOADER

A HEAVY DUTY POWER LOADER MOUNTED ON, PROPELLED AND OPERATED BY A FORDSON TRACTOR

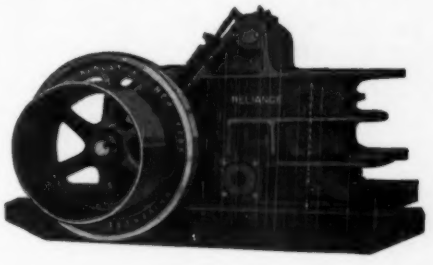
There are sound, practical reasons why the Specialty Loader can hold such a pace day in and day out. In the first place, it's built heavy to stand the strain easily. Secondly, it is backed by the full power of the sturdy Fordson Tractor—nearly twice as much as the average stationary loader of this size.

Write us now for full specifications and details of this efficient, convenient unit, portable under its own power. Easily attached to any Fordson without alteration or drilling of bolt holes. Write us for more complete information or consult any Ford Dealer.

SPECIALTY ENGINEERING CO.

Allegheny and Trenton Aves. Philadelphia, Pa.

There Is A Difference



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RELIANCE CRUSHERS and Handling Units

are built for long, hard SERVICE under the most exacting conditions.

15 to 20 years and more is the usual report of RELIANCE owners, at a minimum cost for maintenance.

We offer a complete line of ROAD BUILDING and QUARRY Equipment in capacities of 50 to 1500 tons per day. Write for catalogue and prices.

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Emerick Street KINGSTON, N. Y.

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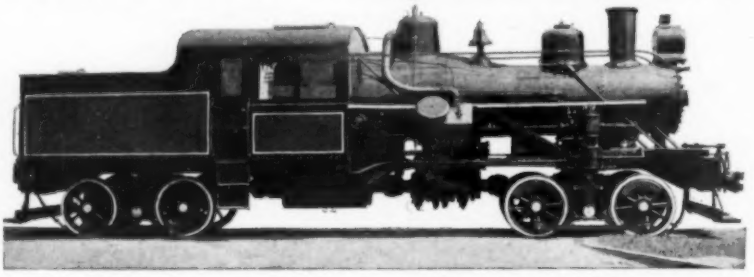

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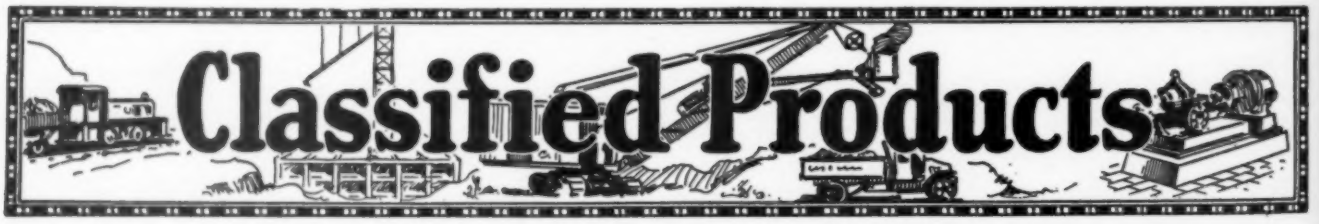

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